University of the State of New York

New York State Museum,

FREDERICK J. H. MERRILL Director
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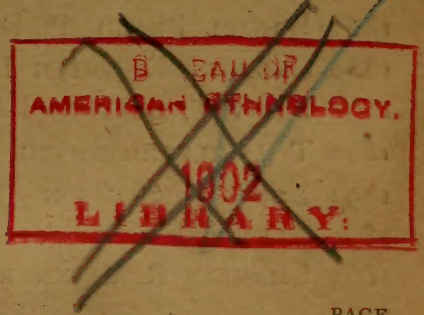
Museum Bulletin 49 December 1901

PALEONTOLOGIC PAPERS 2



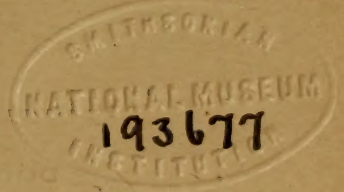


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Plate A

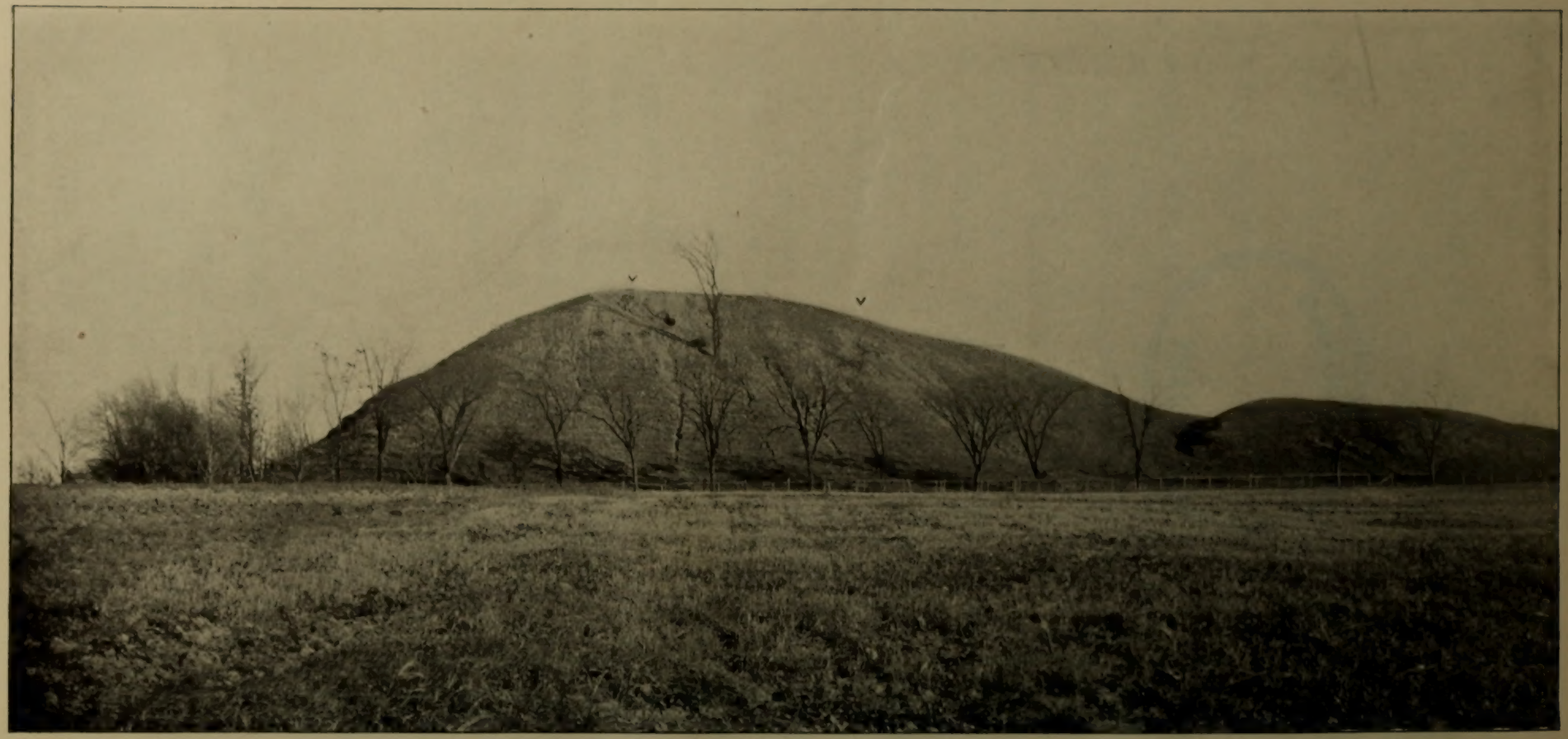

Photo by G. Van Ingen

Rysedorph hill; seen from the west. v v indicate outcrops

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PALEONTOLOGIC PAPERS 2

TRENTON CONGLOMERATE OF RYSEDORPH HILL RENSSELAER CO. N. Y. AND ITS FAUNA

BY RUDOLF RUEDEMANN

INTRODUCTION

From the Rensselaer plateau, which lies on the east side of the Hudson river opposite Albany, and extends from the river plain to the foot of the Taconic mountains, rise a number of ridges trending in a north northeasterly direction. The first of these passes only about one mile east of the city of Rensselaer. It is broken into several hills which, standing out in bold relief from the plateau, are veritable landmarks and can be seen for a great distance on both sides of the river. One of the more conspicuous of these hills is known among the people of the neighborhood by the appropriate name, "The pinnacle." It can be seen from the streets of Albany and readily attracts attention by its steep slopes and its abrupt elevation above the plateau. On the northern brow of the hill projects a mass of very hard limestone conglomerate which, having evidently protected the underlying soft shales from the action of ice and weather, is in some measure the cause of the existence of the hill. A closer investigation of this conglomerate, combined with observations on conglomerate beds farther south in the strike of this bed, has revealed not only the presence of a very interesting fauna but also the notable fact that the pebbles composing this bed vary greatly in their

age. This conglomerate bed is intercalated in the so called Hudson river shales discussed in a previous paper and is thus of still farther interest in its bearing on the question of the age of those shales.

A perusal of the early literature of the New York geologic survey leaves no doubt that this same hill with the capping limestone conglomerate once played a very interesting and important role in the bitter struggle over the Taconic problem.

Dr Emmons was probably the first to notice the locality and collect its fossils; for Hall, in *Palæontology of New York*, 1:35, described among the Chazy fossils a cephalopod as Orthoceras bilineatum, and added:

An examination of this specimen since the plate was engraved convinces me that it is identical with O. bilineatum of the Trenton limestone. This specimen was given me by Dr Emmons as coming from the Calciferous sandstone at a locality 2 miles east of the city of Albany. An examination of the spot has convinced me that the rock in question is the Trenton limestone thrust up through the Hudson river slates. The association of fossils as well as other circumstances prohibit its reference to the Calciferous sandrock.

Dr Emmons, in his endeavor to defend the Taconic system against the aggressions of nearly all his contemporaries, considered the stratigraphy of this locality as of special importance for the demonstration of his assertion that the Siluric beds lie unconformably on the Taconic. In his last defense of his cherished object of research, contained in *American geology*, 1855, pt 2, p. 72, a section of Rysedorph hill[1] is given, which is copied here with the following description of the stratigraphic relations.

At the milldam, the blackish sandstones of the Hudson river dip also east; half a mile further sandstones again crop out, dipping steeply to the west. Just beyond, the green Taconic slates dipping e 10° s support a heavy mass of Calciferous sand-

1 Dr Emmons calls the hill Cantonment hill. Inquiries among the occupants of the neighboring farms brought out the fact that the next hill succeeding in southerly direction was formerly called Cantonment hill on account of a military encampment on it during the war of 1812, and this term has now been perverted into Catamount hill, the present name of that prominence; while the hill described by Dr Emmons passes now under various names, as Sugar Loaf hill, the Pinnacle, Rysedorph hill, etc. As the last name has been adopted on the topographic map of the U. S. geologic survey, it is retained in this paper, though no longer in popular use.

Photo by G. Van Ingen

Rysedorph hill. Nearer view of outcrop of Trenton conglomerate

stone, *a*, and slaty Trenton limestone. Viewing the position of all the rocks, we find that there is an anticlinal axis running at the base of the ridge at *f*, supporting the limestone. The anticlinal is on the line of the great Hudson river fault. The limestone, which is the most important mass, rests unconformably upon the Taconic slates *bb*.

Dr Emmons hence regarded the slates composing the hill as belonging to his Taconic system, and the Siluric beds, which he insisted were Calciferous and Trenton,[1] as lying unconformably on the slates; while Hall, later relinquishing his first view of the upthrusting of the Trenton block, considered the limestone conglomerate to be interlaminated in the Hudson river series. This view is met by Emmons with the following pertinent remark:[2]

Now some paleontologists are willing to admit that a few fossils may go up from the Trenton into the Hudson river series, but I believe that this is the first time that a paleontologist is willing to transfer the whole of the Trenton limestone with all its contents into a higher group.

From a note in the description of the fossils in the cited work of Emmons it appears that this investigator insisted on the Calciferous age of the Orthoceras bilineatum described by Hall from that locality; for[3] it is added after the description, "Calciferous sandstone, Greenbush", and remarked, "Trenton limestone thrust up through the Hudson river slates!!" (the exclamation marks those of Emmons). And it is farther stated that the figure given by Hall of the O. bilineatum from Greenbush differs from specimens from the Trenton. It is insinuated that Hall identified the species as a Trenton form to avoid admitting the presence of the Calciferous sandstone, for "to admit the existence of the Calciferous sandstone below the Trenton at this place would be equivalent to the admission of the Taconic system."

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[1] Emmons recognized the derivation of the pebbles from several formations as is evident from his remarks on this locality in the *Agriculture of New York*. 1846. 1:57, where are cited as found by him in the limestone bed; Maclurea, Bellerophon bilobatus and "masses bearing the character of the Birdseye limestone" and it is concluded that "all these facts put together indicate that this mass of limestone is a mixture of all the lower limestones of the New York system: that they meet in this mass though it is by no means extensive."

[2] Am. geology. 1855. pt 2, p. 72.

[3] Am. geology. 1855. pt 2, p. 149.

Later, this locality was once more mentioned by Walcott in his paper on the Taconic question,[1] where the outcrop is considered a block of Trenton conglomerate caught on the line of the great fault which passes through the hill and which separates the Cambric and Siluric strata. In the light of the knowledge obtained by Ford and Walcott, it was evidently unfortunate that this locality with its complex relations became the object of contention between the early geologists; for, with similar shales, one of Cambric, the other of Siluric age, on opposite flanks of the hill, apparently without any fossils in the immediate neighborhood, the locality was apt to mislead both antagonists. As the writer has demonstrated elsewhere, the Hudson river shales on the east side of the Hudson river belong to the Normans kill zone of graptolite shales and are of Trenton age. Graptolites characteristic of this zone have been found at the western edge of the plateau in Rensselaer in a road metal quarry at the corner of High and 2d streets. The assumption of the intercalation of this supposed Trenton conglomerate in the shales which are of Trenton age, would, therefore, involve no serious incongruity; in fact, a conglomerate bed with the same fauna, the same kind of pebbles and matrix, has been observed by the writer a few miles farther south at the Moordener kill, intercalated in graptolite-bearing shales. The question whether the bed on Rysedorph hill is intercalated in the shales or is a block thrust up along a fault, is therefore, of no great theoretic importance for our investigation; but it may be stated that the appearance of the isolated bed, which seen from the top is folded on itself, is quite suggestive of its having been carried along the overthrust fault. Under this assumption, however, it is evident that the conglomerate block can not be far removed from its mother bed, and that the latter must be intercalated in the great mass of Normans kill shales at no great depth.[2]

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[1] Am. jour. sci. 1888. 35 :319.

[2] A. S. Tiffany exhibited at the Washington (1891) and Rochester (1893) meetings of the Geological society of America some fossils from the Rysedorph hill outcrop and published his observations in a small separate paper. In this he considers the bed a Trenton limestone and cites the following fossils: Streptorhynchus filitextum Hall, Leptaena sericea Sow., Orthis dichotoma Hall, Strophomena alternata Con., S. alternistriata Hall, Asaphus gigas DeKay.

The intercalation of a similar bed in Normans kill graptolite shale, at Schodack Landing, 20 miles farther south, was made known by S. W. Ford.[1] He describes it as being 2 feet thick, and in part, somewhat brecciated in appearance. From the mode of occurrence of this bed, he has no doubt that it is a regular member of the slate formation. It furnished to him: Isotelus gigas, Calymmene senaria, Dalmanella testudinaria, Platystrophia biforata var. lynx, Plectambonites sericea, Rafinesquina alternata, and the hemispheric variety of Chaetetes lycoperdon. Both the limestone and its associated graptolitic slates represent, in his estimation, the Hudson river group. A visit to this interesting locality, which lies in the direct strike of the Rysedorph hill and Moordener kill outcrops, convinced the writer that it is a third exposure of the same conglomerate bed, containing the same groups of pebbles, though in different relative quantities. A fourth exposure of the same conglomerate, observed by Ford just south of Schodack Landing in a ravine, running along the Columbia county line was not found again and is probably covered at present by alluvial deposits. Still another outcrop occurs near the boathouse of the Mohican canoe club, on Papskanee island between Albany and Castleton.

In all three localities the matrix consists of a dark gray to black arenaceous limestone, which weathers into a drab sandstone, the Calciferous sandrock of Emmons. At the Moordener kill it has a strong admixture of mud and also an admixture of numerous fragments of shale, which, however, may have been forced into it from the surrounding rock during the folding of the beds. The pebbles, which by lithologic and faunistic differences can be divided into seven groups, are irregularly mixed, mostly well worn, and of very different size; the latter characteristic in some measure depending on the hardness of the rock. The seven groups of pebbles are:

1 Lower Cambric limestone, represented by a single pebble found in the Rysedorph hill conglomerate, which is in lithologic

[1] Am. jour. sci. 1884, 28:207.

appearance identical with the lower Cambric conglomerate limestone of Troy and contains Hyolithellus micans Billings, a characteristic fossil of that locality.

2 Pebbles of nonfossiliferous grayish and reddish sandstones which may represent in age the Potsdam sandstone or Beekmantown limestone beds, or may be derived from sandstone beds in the underlying Normans kill graptolite shale. They are the strongly prevailing class of pebbles at Schodack Landing, have diminished in number at the Moordener kill, though still outnumbering the limestone pebbles, and are greatly reduced in relative quantity farther north, on Rysedorph hill.

3 Pebbles of a black, hard limestone, which appears crystalline by the profuse admixture of crystallized cystid plates. This class, which is represented by only a few pebbles found on Rysedorph hill, is similar in lithologic appearance to the Chazy limestone as exposed near Valcour on Lake Champlain. It has been found to contain Bolboporites americanus Billings, a characteristic Chazy fossil (see p. 11) and Paleocystites tenuiradiatus Hall.

4 The Lowville limestone is represented by hard, bluish gray pebbles with numerous birdseyes, Phytopsis tubulosa Hall, which differ in nothing from the Lowville limestone beds as exposed along the Mohawk and Black river valleys. At the Moordener kill also Tetradium cellulosum Hall sp., a characteristic fossil of the Lowville limestone, has been collected. The pebbles of this group, though not prevailing in any of the localities, are the most striking by their color, and in size they far surpass all others. At Schodack Landing boulders of a foot and a half in diameter have been observed. Opposite the railroad station, in the conglomerate of the rocky wall behind the village, they can be noticed from the car windows. At the Moordener kill boulders a foot in diameter occur. Their large size is evidently due to their great hardness, for their relatively small number and strongly water worn rounded surface indicate their derivation from a more distant place. On Rysedorph hill only a few small pebbles were found.

5 This group consists of mostly small pebbles of a very hard, compact limestone, intensely black when fresh, but very soft and of brownish tint when weathered. These were found in the conglomerate of Rysedorph hill and the Moordener kill, none being obtained at Schodack Landing. They contain a most interesting fauna, new and peculiar species of trilobites, brachiopods, and gastropods, described in another part of this paper. This limestone will be cited in the descriptions and lists as "compact black limestone."

6 Very commonly on Rysedorph hill and rarely also at the Moordener kill occur pebbles of a very hard, compact, fine grained, dark gray limestone, which weathers into a reddish gray rock, and therefore will be cited in this paper as the "compact, reddish gray limestone." It has been found to contain rarely a few of the fossils of the preceding limestone, while it never fails to contain ostracodes, some of the pebbles showing the tiny, black, glossy fossils with wonderful distinctness. The most common of these are Bythocypris cylindrica Hall, a variety of Schmidtella crassimarginata Ulrich, and Eurychilina reticulata Ulrich.

7 The last group of pebbles consists of a light gray crystalline limestone, which often changes into a veritable shell rock. The greater number of these is largely made up of Plectambonites sericea showing a varietal development, others consist of Rafinesquina alternata or parts of Isotelus gigas. This group of pebbles is by far the prevailing class in the Rysedorph hill conglomerate, and is still common at the Moordener kill, but has become greatly diminished at Schodack Landing, the relative quantity of these and the sandstone pebbles being, roughly stated, inversely proportional.

A farther discussion of the character and composition of this conglomerate bed can not be carried on advantageously till after the description of the species and the determination of the taxonomic relations of the faunas of the last three groups of pebbles.

The unmistakable presence of pebbles of Chazy limestone

(group 3) and the occurrence of such forms as Ampyx and Remopleurides in the limestone pebbles of groups 5 and 6 have been a cause of no little concern to the writer, lest a failure to separate the pebbles properly might cause a confusion of the faunas, specially as both groups consist of black limestone pebbles; special attention has therefore been paid to the association in the same pebbles of these new species with other well known fossils; and in the descriptions the most important associates have been mentioned. It has thus been found that nearly every pebble of groups, 5, 6, 7 were characterized by a typical Trenton form, removing thus the danger of a confusion with the Chazy limestone.

DESCRIPTION OF FAUNAS

ANTHOZOA

STREPTELASMA Hall

Streptelasma corniculum Hall. Pal. N. Y. 1847. 1:69

A number of specimens of a coral fully agreeing in external and internal characters with Streptelasma corniculum, were found in pebbles of black limestone of the Rysedorph hill and Moordener kill conglomerates, as well as in the matrix of the conglomerate at Schodack Landing. Several specimens represent the variety described by Hall as Streptelasma parvula. Streptelasma corniculum occurs in the Trenton, from Baffin Land[1] over Canada and New York as far west as Minnesota, but does not seem to go either above or below that formation. (Group 5)

TETRADIUM Dana

Tetradium cellulosum Hall *sp.*

Phytopsis cellulosum Hall. Pal. N. Y. 1847. 1:39

This index fossil of the Lowville limestone was found in boulders of light gray limestone in the Moordener kill conglomerate, which in their lithologic appearance show no difference from the Lowville limestone of the Mohawk and Black river valleys. (Group 4)

[1] Schuchert. U. S. nat. mus. Proc. 1900. 22:154.

BOLBOPORITES Pander

Bolboporites americanus Billings. Can. nat. and geol. 1859. 4:429

Pl. 1, fig. 1

This North American representative of the Russian Lower Siluric genus Bolboporites is according to Billings characterized by "a solid hemispherical base surmounted by a conical projection which is celluliferous, the cells being about the size and shape of those of the common Stenopora fibrosa." Specimens collected in the Champlain region, about Valcour, where this organism is extremely common in certain beds, show that the celluliferous projection is somewhat variable and may be ellipsoidal as in the specimen figured. While the taxonomic position of this body appears to be still doubtful, its value as an index fossil for the Chazy period is determined by the fact that no other representative of this genus has thus far been found in beds of any other period. According to Brainerd and Seely it is restricted to the lower Chazy. Specimens of this species were found at Rysedorph hill in pebbles of a black, crystalline crinoidal limestone, associated with plates of Palaeocystites tenuiradiatus Billings, another characteristic Chazy fossil. (Group 3)

DIPLOGRAPTUS McCoy

Diplograptus foliaceus Murchison *sp.*

Graptolites foliaceus Murchison. Silurian system. 1839. p. 695

A few rhabdosomes of this widely distributed and long-lived species were found in the black limestone pebbles associated with Trenton fossils. (Group 5)

CLIMACOGRAPTUS Hall

Climacograptus scharenbergi Lapworth

Climacograptus scharenbergi Lapworth, in Armstrong, Young and Robertson's Catalogue of west Scottish fossils. 1876. p. 140

Pl. 3, fig. 1

Climacograptus scharenbergi, an easily recognized graptolite, was found by Lapworth to occur in the lower

and upper Dicellograptus shales of Canada, and is also not unfrequent in the lower Dicellograptus or Normans kill shales of New York. In the conglomerate of Rysedorph hill it was found embedded in black compact limestone, associated with Pterygometopus callicephalus, Ampyx hastatus, Callopora multitabulata. (Group 5)

CRINOIDEA

Joints of stems only are found to constitute some gray limestone pebbles of Rysedorph hill. (Group 7)

CYSTIDEA

Plates of Palaeocystites semiradiatus Billings were found in the crystalline, black Chazy limestone, and a few plates of a Glyptocystites in the compact, black Trenton limestone, associated with Illaenus americanus and species of Tretaspis. (Groups 3 and 5)

BRYOZOA

STOMATOPORA Bronn

Stomatopora inflata Hall *sp.*

Alecto inflata Hall. Pal. N. Y. 1847. 1:77

Pl. 1, fig. 2, 3

Zoaria of this pretty bryozoan were found to grow frequently on the cranidia and pygidia of Isotelus maximus in the black compact limestone; they show the characters of the species as first described by Hall and later more fully defined by Ulrich. A finely preserved group attached to a Rafinesquina deltoidea shows a remarkable variation from the typical expression of Stomatopora inflata in having the zooecia abruptly contracted, and the proximal end tubular and slender, thus closely approaching a form described by Ulrich as Stomatopora turgida from the upper beds of the "Hudson river group" at Wilmington Ill.; the difference between the two consisting in the more spheric shape of the inflated part in the Hudson river form and the more pyriform to cylindric development of the same part in the Rysedorph hill specimens (fig. 3). The lack of frequent branching is also common to both.

STICTOPORA Hall

Stictopora elegantula Hall. Pal. N. Y. 1847. 1:75

Small parts of a bryozoan were found, which, on account of their fragmentary character, do not permit an accurate determination, but their oval apertures with strongly raised margins, permit their comparison with Stictopora elegantula Hall. (Group 5)

CALLOPORA Hall

Callopora multitabulata Ulrich

Monotrypella multitabulata Ulrich. Geol. and nat. hist. sur. Minn. 14th an. rep't. 1886. p. 100.

Many of the compact black limestone pebbles are fairly filled with a branching, subcylindric bryozoan, the surface of which could not be observed, as no weathered surfaces were found; their sections, however, reveal their identity with Callopora multitabulata Ulrich. Ulrich reports this organism from the middle and upper Trenton of Minnesota, the Trenton of Kentucky, Tennessee, and as probably occurring at Ottawa Can. (Group 5)

PRASOPORA Nicholson & Etheridge jr

Prasopora simulatrix Ulrich, *var.* **orientalis** Ulrich. Geol. and nat. hist. sur. Minn. 1895. v. 3, pt 1, p. 246

In the black compact limestone pebbles of Rysedorph hill, a few of the large hemispheric bodies, so widely known from the Trenton under the designation Chaetetes lycoperdon Hall, were found. As pointed out by Nicholson, no definition of this species has ever been given by either Vanuxem or Hall, or any subsequent writer, which can be regarded as in any sense sufficient, while it is certain that this name has been applied by different writers to wholly different forms. As Vanuxem's figure, which gives the external form only, and Hall's figures, which evidently include many forms, are no satisfactory proof as to the species on which the name was founded, Nicholson proposes to drop it altogether; Ulrich concurs, adding: "It would not be difficult to show that since 1842 no less than one hundred distinguishable forms have been included under this indefinite general designation."

The form found at Rysedorph hill proved, by thin sections, to be a Prasopora, identical with Prasopora simulatrix Ulrich, and very probably representing his var. orientalis, which is common in the Trenton limestone of Trenton Falls and Ottawa. (Group 5)

BRACHIOPODA

SIPHONOTRETA de Verneuil

Siphonotreta minnesotensis Hall & Clarke. Pal. N. Y. 1892. v. 8, pt 1, p. 177

Pl. 1, fig. 4, 5

A single but well preserved pedicle valve of a species of Siphonotreta was found in a pebble of black compact limestone associated with cranidia of Pterygometopus callicephalus.

As only two species on this continent have thus far been referred to Siphonotreta, i. e. S. (?) micula McCoy from the Beekmantown horizon of Canada, and S. (?) minnesotensis Hall and Clarke, from the Stones river beds of Minnesota, and as our form agrees with the latter species in all important features, it seems advisable to refer this valve at present thereto. Of both of these species the pedicle valve is completely known, and, on this account, their relation to the European genus Siphonotreta is still doubtful. The specimen from Rysedorph hill supplies this desired information for Siphonotreta minnesotensis.

The pedicle valve found is broadly subovate in outline, depressed convex, with a straight, elevated, at first conic, but terminally cylindric beak, rising a little posteriorly of the center of the valve and extending beyond the cardinal margin. Beak perforated, foramen round and apical. Median part of shell depressed, lateral parts low, convex, increasing rapidly in slope toward the lateral margin. Surface of the umbonal region nearly smooth, with faint concentric wrinkles which rapidly increase in strength anteriorly. From the wrinkles proceed numerous straight, thin spines, which attain the full length of the shell, extending far beyond the anterior and lateral margins.

Dimensions. Length 3.9 mm, width 3.7 mm, hight 4 mm.

Horizon and locality. Black compact limestone pebble of conglomerate of Rysedorph hill.

Observations. In common with the only other pedicle valve of Siphonotreta minnesotensis known, this form has the depressed median region and the concentric wrinkles, while it differs in size and the relative length of the spines, the latter being much larger in the New York specimen. The importance of this difference can, with only the two pedicle valves known thus far, not be properly adjudged.

The interesting feature of the specimen from Rysedorph hill is that it shows distinctly the elevated conic beak with perforated apex, a feature distinctive of the genus Siphonotreta, as restricted and more properly defined by Hall and Clarke.[1] As remarked before, the other American specimens tentatively referred to this genus have not furnished sufficient data for their generic determination. The specimen from Rysedorph hill indicates that Siphonotreta minnesotensis is the first undoubted American representative of that peculiar, eminently lower Siluric genus, which is well represented in Europe and extends with but one species into the upper Siluric. (Group 5)

CRANIA Retzius

Crania cf. **trentonensis** Hall. Descriptions new species Crinoidea and other fossils. 1866. p. 12

In the black compact limestone of Rysedorph hill a small internal cast of a Crania was found, showing two deep divergent oval central muscle pits on the apex and a third shallow one below. As the internal parts of the Trenton species of Crania are not yet known, a closer comparison is not possible.

PHOLIDOPS Hall

Pholidops trentonensis Hall. N. Y. state cab. nat. hist. 24th an. rep't. 1872. p. 221

A single but finely preserved specimen with regular oval outline and strong lamellose growth lines was found in the compact

1 Pal. N. Y. 1892. v. 8, pt 1, p. 177.

black limestone of Rysedorph hill. The specimen is smaller by one half than the average specimens of Pholidops trentonensis; but, it being the only specimen found, a comparison with the variety Pholidops trentonensis var. minor Winchell and Schuchert, from the base of the Galena limestone at St Paul, is excluded. Judging from the drawing given of that form, the Rysedorph hill specimen shows the same slight truncation as the western form, which becomes more emphasized in Pholidops subtruncatus.

Hall does not give the exact horizon of his species, which was secured at Middleville, and Dr White and Prof. Prosser did not find the fossil in the sections of Trenton Falls and other localities along the West Canada creek; the western variety occurs in the Black river and lower Trenton beds. (Group 5)

RAFINESQUINA Hall & Clarke

Rafinesquina alternata (Emmons) Hall & Clarke

Leptaena alternata Emmons. Geol. of N. Y. Rep't on second district. 1842. p. 395

Pl. 2, fig. 1

Many pebbles of the gray crystalline limestone of Rysedorph hill are filled to the exclusion of other fossils with very large specimens of Rafinesquina alternata. The extreme size of a great number of specimens, combined with a remarkable extension of the cardinal region, constitutes a striking variation from the type, which becomes more emphasized in such Lorraine forms as Rafinesquina alternata loxorhytis Meek. Numerous other specimens are remarkable for the strong oblique corrugation of their cardinal regions. Several specimens of great gibbosity and thick shell were also found in the compact reddish gray, ostracode limestone of Rysedorph hill. Rafinesquina alternata is also of frequent occurrence in the matrix of the conglomerate at the Moordener kill and at Schodack Landing. This form ranges from the Chazy to the Lorraine beds and extends from Canada to Minnesota and Manitoba. (Group 7)

Rafinesquina deltoidea Conrad *var.* An. geol. rep't. 1838. p. 115

In the gray, crystalline limestone occurs a Rafinesquina, which, on account of certain peculiarities, is worthy of notice. While it has the outline of Rafinesquina deltoidea, it is more convex, holding in this feature an intermediate position between R. deltoidea and R. camerata, as figured by Hall, and it lacks the concentric wrinkles on the depressed convex central disk, usually occurring in both of these species. Its most striking feature, however, is the entire absence of the fine radiating striae between the coarse ones, having only about 15 prominent, equidistant striae on an otherwise smooth shell. In view, however, of the great variations of R. alternata and its allies, R. camerata and R. deltoidea, on account of which it is often difficult to even assign a normal form to any of these three species, it would seem unwarranted to give any importance to such a varietal difference, if it were not for the fact, that the whole fauna of the conglomerate differs in so many of its constituents from the other New York faunas, thereby giving also to such varietal differences a certain significance in the comparison of provincial faunas.

According to Hall the species abounds in the Trenton limestone at Trenton Falls and at Sugar river in Lewis county and is scarcely known to occur in the Champlain valley. Dr T. G. White found that it characterizes certain Middle Trenton beds at Trenton Falls, and that it also occurs in the Trenton of the Champlain valley. Winchell and Schuchert report it from the middle and upper Trenton and the Lorraine beds of localities in Minnesota and Wisconsin; and according to Davidson[1] it is widely distributed in the Caradoc of Great Britain and through corresponding beds of Norway and Russia. The latter statements, however, are questioned by Winchell and Schuchert, as the identity of the European and American forms is still doubtful. (Group 7)

[1] Monograph Brit. Sil. Brach. 1871. v. 3, pt 7, p. 292.

LEPTAENA Dalman

Leptaena rhomboidalis Wilckens. Nachricht von seltenen Versteinerungen. 1769. p. 77

Leptaena tenuistriata Hall. Pal. N. Y. 1847. 1:108

Specimens of this long-lived species were found to occur in the black as well as in the crystalline, gray and compact, reddish limestone pebbles; in the first quite frequently and in large typical specimens, in the latter two in smaller specimens with strong corrugations on the disk, abruptly inflected margin, and the extension of the hinge line forming rather long, acute ears. Leptaena rhomboidalis occurs as well in Europe as in America, and ranges here from the Trenton up into the Carbonic. (Groups 5, 6, 7)

PLECTAMBONITES Pander

Plectambonites sericeus Sowerby *sp.*

Leptaena sericea Sowerby, in Murchison's Silurian system. 1839. pl. 19

Large typical specimens occur occasionally in the black compact limestone pebbles. (Group 5)

Plectambonites sericeus Sowerby, *var.* **asper James**

Leptaena aspera James. Cin. quar. jour. sci. 1874. 1:151

Pl. 1, fig. 6, 7

A variety with distinct cardinal corrugations was cited by James in his list of the Cincinnati fossils as Leptaena aspera. Later, Meek[1] described and figured this variety, stating that it has a large and proportionally wide shell with a straighter anterior margin, and the area of its dorsal valve more inclined forward. A form which shows these characters, with constant strong corrugations, occurs in immense numbers or rather composes the greater number of pebbles of gray limestone at Rysedorph hill, the Moordener kill and Schodack Landing, and is also very common in the matrix at these localities. The corrugations are oblique, acute, sharply terminating, large at the cardinal extremities and decreasing in length toward the beak. As the specimens marked characteristically in this manner pre-

[1] Pal. Ohio 1873. 1:70.

vail, and specimens without the corrugations are only rarely observed in the gray limestone, these forms seem to represent a local and perhaps provincial variety and aid in indicating provincial differences in the Trenton faunas of New York. These varietal features, specially the strong corrugations, seem not to be of frequent occurrence in other places, for none are mentioned in the full descriptions of Leptaena sericea by Hall, Sardeson, Winchell and Schuchert. The collections of the state museum prove that such forms are occasionally, though rarely found in the Trenton of other parts of the state; and specimens found at the old Dudley observatory, Albany and at Green Island give evidence that in this region it passed also into the upper Utica beds. In the latter localities it is frequently intermingled with typical specimens and can therefore hardly be considered a different species. (Cement and group 7)

Plectambonites pisum *sp. nov.*

Pl. 1, fig. 8–20

There occurs rarely in the gray crystalline limestone, and very profusely in the black compact limestone, a small, extremely gibbous species of Plectambonites which may be described as P. pisum.

Diagnosis. Shell small, semicircular in outline, with subauriculate cardinal extensions; highly concavo-convex, the convexity surpassing that of a hemisphere; toward the cardinal ears becoming depressed convex; length to width as 4:5, greatest width along the hinge line, which is nearly straight. Surface marked with very fine striae, which usually are interrupted by from 16 to 20 coarse striae; sometimes the fine striae become nearly obsolete, leaving the interspace between the coarse striae almost smooth; at other times the coarse striae disappear, leaving the shell uniformly and finely striated; a few concentric growth lines are also present. Pedicle valve extremely gibbous, the greatest elevation being in the central part; the umbonal part sloping abruptly; the umbo being protuberant and projecting beyond the cardinal line; anterior and lateral slopes less abrupt,

near the margins turning suddenly into a flatter border. Cardinal area moderately elevated, concave, delthyrium large, of equal width and length; no deltidium observed. Teeth small, supported by strong, diverging dental lamellae, which continue in outward direction into the much elevated margin of the diductor muscles; this margin extends about one fourth the length of the valve, and then returns under an acute angle including a very deep pyriform muscle pit. The muscle margins are separated by a distinct septum, which extends to near the anterior margin; from the anterior part of the muscular impressions extend strongly marked vascular trunks which are tri- or quadripartite and inclose between them a narrow elongate depressed area. Brachial valve concave in the middle part, closely following the curvature of the pedicle valve, with a well defined ridge all around the lateral and anterior margin. Cardinal area as high as that of the pedicle valve and also slightly concave, retrorse, with a large chilidium, somewhat concave in the middle. Cardinal process single and erect and, by its coalescence with the divergent, short, crural plates, appearing distinctly trilobate at its posterior end, similarly to P. s e r i c e u s, with the difference, however, that the posterior ends of the crural plates are not closely appressed to the cardinal process, but separate again a little, forming processes almost as prominent as and parallel to the cardinal process (pl. 1, fig. 18). Adductor scars shallow, broadly triangular, extending not quite to the middle of the shell, slightly divergent, inner margins formed by two ridges, branching from the crural processes and extending to near the anterior margin; outer somewhat indented margin of the muscular impressions greatly elevated as in P. g i b b o s u s Winchell and Schuchert.

Dimensions. Length 8.5 mm, width 10.2 mm, hight 5.5 mm.

Horizon and locality. Extremely common in the pebbles of compact black limestone in the conglomerates of Rysedorph hill and Moordener kill, rare in the matrix and very rare in the gray crystalline limestone pebbles. (Groups 5, 7 and matrix)

Observations. From P. sericeus this form differs in the shape of the valves and their internal characters, no transitions being found between the two. In outline it approaches more the P. transversalis of the upper Siluric, specially in the projection of the umbo beyond the cardinal line and in the rounded cardinal ears, but it has quite different muscle scars in the brachial valve. It also shows a certain similarity to Leptella decipiens Billings, from the Beekmantown horizon of Quebec; it differs from that form, however, in being more convex and by its internal characters. Its nearest relation is undoubtedly with P. gibbosus Winchell and Schuchert, from the middle Trenton of Minnesota, from which form it differs in its surface characters, having 16 to 18 coarser striae to the six or seven of the western form; in being still more gibbous and abruptly so in the central part; and in its outline, in having the umbo project beyond the cardinal line and possessing marked subauriculate cardinal extensions. Judging from the drawings the western form seems also to be less rounded and more subtriangular in outline. A small European form, which from the description and figures furnished by Davidson[1] is apparently related to our species, specially in the shape and relative size of the muscle impressions is Leptaena scissa Salter. It occurs in the Caradoc and Llandovery beds of Great Britain.

CHRISTIANIA Hall & Clarke

Christiania trentonensis *sp. nov.*

Pl. 2, fig. 2–6

The most interesting brachiopod of the fauna of the black compact limestone pebbles is a new species of the rare genus Christiania, thus far represented in North America only by a Helderbergian form.

Diagnosis. Shell small, convexo-concave, somewhat variable in shape, rotundo-quadrate to rotundo-rectangular, sides subparallel or slightly converging to the cardinal line; front rounded. Hinge line straight, only slightly shorter than the greatest

1 Foss. Brach. Pal. soc. 1861. v. 24, pt 3, no. 4, p. 325.

width of the valve in the middle part; cardinal extremities obtusely angular, having the appearance of flattened ears. Pedicle valve uniformly and strongly convex; umbo slightly projecting and very narrow, beak obscure. Cardinal area narrow (?); interior of pedicle valve not observed. Brachial valve strongly concave, beak hardly projecting beyond the long, straight hinge line. Cardinal extremities strongly developed, flat; area very small; cardinal process small, bipartite on its anterior face; the lobes being denticulate anteriorly with from three to five small denticles on each side. Crural plates very long and slightly divergent; the lower portion produced on each side as a strongly elevated wall with perpendicular sides extending in the original direction of the crural plates close to the ante-lateral angle, where it recurves and returns, parallel to the median axis and nearly in a straight line as a still more prominent wall merging into the base of the cardinal process. The elongate, symmetric, subrectangular spaces thus formed are each divided transversely by a vertical ridge about one third of the length of the valve from the cardinal line. The long narrow space between the inner muscular walls is also bounded anteriorly by a low, rounded, curving ridge and divided in the median line of the shell by a low, rounded, longitudinal ridge. The anterior half of the surface of the long anterior adductors is very rugose and radially striated.

The surface is covered with concentric lines of growth and radiating, quite widely separated, filiform striae with smooth, flat interspaces.

Dimensions. Length 9.7 mm, width 8.9 mm, hight 3.1 mm.

Horizon and locality. Rysedorph hill. The few specimens obtained, among them a finely weathered interior of a brachial valve, were found in the pebbles of black compact limestone, together with *Plectambonites sericeus*, *Plectambonites pisum* and *Orthis tricenaria*. (Group 5)

Observations. The genus Christiania was proposed by Hall and Clarke for such species, formerly included in Leptaena, as differ

in the surface ornamentation, composition of the cardinal process, arrangement of the muscle scars, and specially in the great muscular scars and their high walls. Three species are cited as clearly referable to this genus, viz Christiania subquadrata Hall, from the Helderbergian (?) group of Tennessee, Christiania tenuicincta McCoy sp. from the upper Llandeilo and the Caradoc series of Great Britain, and Christiania oblonga Pander sp. from the lower Siluric beds of the vicinity of St Petersburg.

A comparison of our species with the descriptions and figures of these three species brings out the fact that it is more closely related to the two European lower Siluric species than to the American Devonic; for the general form, it seems, is of little value for a comparative study, as both the English and the Russian forms vary greatly between short, broad and elongate forms, as is fully demonstrated by the figures given by Davidson [1] and by Murchison, Verneuil, and Keyserling [2] and also by the writer's specimens. While, however the Devonic form has the cardinal angles rounder and little produced, the surface smooth or only marked by squamous growth lines and the external lateral wall of the anterior adductor muscle in the brachial valve inflected in front of the crural processes, the British and Trenton species have rather strongly developed cardinal extremities, and the Russian and the Trenton forms have the longitudinal surface striae in common, for Murchison, Verneuil, and Keyserling report that specimens occur which have a striation like Leptaena sericea. Judging from the figures given in the *Geologie de la Russie d'Europe* the external walls of the anterior adductor muscles in the Russian form are straight continuations of the crural processes as in the Trenton form. Perhaps, however, to the latter character no great importance should be attached, as Davidson figures a brachial valve of Christiania tenuicincta with just such straight lateral walls among the other valves with inflected lateral walls, such as the Devonic form has.

[1] Monograph Brit. foss. Brach. Sil. suppl. 1883. v. 5, pt 2, pl. 12, fig. 17–21, and v. 7, no. 4, pl. 47, fig. 7–18.

[2] Geol. de la Russie d'Europe etc. 1845. pl. 15, fig. 2a-f.

Among the Russian forms is figured a pedicle valve with depressed umbo and very convex pallial region, which is quite similar to our form. Taking all these facts into account, it appears that the internal characters will hardly furnish any points of difference between the forms, and that, when the general form and the exterior are compared, the Trenton form combines the cardinal extremities of the British with the striated surface of the Russian species.

TRIPLECIA Hall

Triplecia nucleus Hall

Atrypa nucleus Hall. Pal. N. Y. 1847. 1:138

A small Triplecia, evidently identical with Triplecia nucleus Hall, was found to be common in the gray crystalline limestone pebbles of the conglomerate; a few specimens were also obtained from the compact reddish limestone with ostracodes. Triplecia nucleus has thus far been found only in the middle Trenton of New York. (Groups 6, 7)

ORTHIS Dalman

Orthis tricenaria Conrad. Acad. nat. sci. Phil. Proc. 1843. 1:333

Orthis tricenaria occurs quite frequently in typical specimens of somewhat smaller size than those from the western side of the Adirondacks, in the gray crystalline and compact black limestone pebbles and in the cement. Its similarity to the Chazy form, Orthis costalis, together with the occurrence of numerous cranidia and pygidia of Ampyx and Remopleurides in the compact black limestone was at the first collecting quite suggestive of the Chazy age of the compact black limestone pebbles; a suggestion, however, which the common occurrence of typical Trenton fossils in the same pebbles proved to be misleading. (Cement and groups 5, 6)

Orthis tricenaria is reported by Hall from the lower Trenton of Middleville; in the west it ranges from the Stones river (Lowville) beds through the Black river beds into the Trenton. Dr White did not locate it in the Trenton and Rathbone brook sections.

PLECTORTHIS Hall & Clarke

Plectorthis plicatella Hall

Orthis plicatella Hall. Pal. N. Y. 1847. 1:122

Several large specimens of this species were found in the gray crystalline limestone pebbles. Hall reports the form as very rare in the lower Trenton of New York, while in the west it is common from the upper Trenton to the Lorraine beds. It has lately been found to ascend into the upper Utica beds in the vicinity of Albany. (Group 7)

PLATYSTROPHIA King

Platystrophia biforata Schlotheim *sp.*

Terebratulites biforatus Schlotheim. Petrefactenkunde. 1820. p. 265

With one exception all specimens of Platystrophia biforata, which is quite common in the compact black limestone pebbles, are only middle-sized, have rounded cardinal angles and only five to six not very strongly developed plications on either side of fold and sinus, while the usual number is from 12 to 16 plications on either side, and at least 12 in Trenton specimens of the same size from New York. As Winchell and Schuchert[1] state that the earliest individuals of this species, which ranges from the Chazy to the Niagara formation, are small in size and have but few and simple costae, characters which also appear in the young individuals, the immature characters of the specimens collected at Rysedorph hill point to a rather early age for the black limestone. (Group 5)

DALMANELLA Hall & Clarke

Dalmanella testudinaria Dalman *sp.*

Orthis testudinaria Dalman. Kongl. Svenska. vet. akad. Handl. for 1827. 1828. p. 115

Dalmanella testudinaria is very common in the gray and black compact limestone pebbles of Rysedorph hill, Moordener hill and Schodack Landing. (Groups 5, 7)

[1] Geol. Minn. Pal. 1897. v. 3, pt 2, p. 456.

Dalmanella subaequata Conrad, *var.* **pervetus** Conrad

Orthis perveta Conrad. Acad. nat. sci. Phil. Proc. 1843. 1:333

In the gray crystalline limestone, valves of a Dalmanella were found, which on account of their rather broad form, somewhat ventricose valves with a broad distinct sinus in the pedicle valve, and numerous thin bifurcating striae, have been referred to the group of Dalmanella subaequata. Winchell and Schuchert suggest that only the variety pervetus of Dalmanella subaequata occurs in New York and Canada. In the strong development of their somewhat angular sinus, in the character of the striae, which are a little coarser than the figures of Dalmanella subaequata would indicate, all the writer's specimens agree better with that variety, though they are of slightly larger size than the measurements and figures given by Conrad and Hall require, and in this regard corresponding better with the specimens figured by Winchell and Schuchert. Dr White reports D. subaequata from the Lower and Middle Trenton of the Trenton and Rathbone brook sections in New York. (Group 7)

PARASTROPHIA Hall & Clarke

Parastrophia hemiplicata Hall

Atrypa hemiplicata Hall. Pal. N. Y. 1847. 1:144

Parastrophia hemiplicata was found in the gray crystalline limestone in a few rather gibbous specimens with not very strongly developed folds. This form, which has a wide geographic distribution, having been reported by Schuchert from Baffin Land and also from the northwest, is considered to be restricted to the Trenton, but it has been found in the upper Utica beds of the neighborhood of Albany, and is reported by White as marking a zone in the upper Black river beds near Boonville. (Group 7)

PROTOZYGA Hall & Clarke

Protozyga exigua Hall

Atrypa exigua Hall. Pal. N. Y. 1847. 1:141

This small form was found to be quite common in the pebbles of gray crystalline and compact reddish gray limestone. While

the specimens obtained agree in all essential features with the New York form, as originally described by Hall, showing also the extended cardinal line and the slight inflection of the brachial valve toward the cardinal extremities (features which are more distinctly shown in the figures given by Hall and Clarke[1]) it bears from three to four marginal folds on either side and on both valves, a character mentioned by Hall and Clarke and more distinctly shown in the specimens described as Zygospira aquila by Sardeson and as Hallina nicolleti by Winchell and Schuchert. Hall reports the form from the "central part of the Trenton limestone at Lowville and near Martinsburg, Lewis county". Of later collectors it is mentioned only by Dr White from the Black river beds at Boonville and the Black river, but not from the Trenton Falls or the West Canada creek sections. Hallina nicolleti is reported by Winchell and Schuchert from beds corresponding to the New York Lowville limestone and from the upper third of the Trenton limestone in Minnesota and Iowa. More extensive observation in this state may therefore show its range to extend from the Lowville limestone through the Black river beds into the Trenton. (Groups 6, 7)

ZYGOSPIRA Hall

Zygospira recurvirostris Hall

Atrypa recurvirostris Hall. Pal. N. Y. 1847. 1:140

Zygospira recurvirostris is not infrequently found in the pebbles of gray crystalline limestone in the Rysedorph hill conglomerate. The specimens obtained present no features distinguishing them from the typical material, with the possible exception that the sinus is rather weakly developed. Hall reports that this shell occurs in considerable numbers near the middle of the Trenton limestone near Martinsburg, Lewis co. and that it also has been seen at Lowville and Middleville. White found it in the Black river beds of the Rathbone brook section, as well as in various horizons of the Trenton Falls section. In Canada and in the west it rises from the Lowville beds into the Trenton. (Group 6)

[1] Pal. N. Y. 1892. v. 8, pt 1, pl. 54, fig. 47-48.

PELECYPODA

MODIOLOPSIS Hall

Modiolopsis aviculoides Hall. Pal. N. Y. 1847. 1:161

Two internal casts were found in the gray crystalline limestone which are referred with some doubt to Modiolopsis aviculoides Hall, a little known species with which they agree in the outline of their somewhat ventricose valves, oblique cardinal lines, prominent umbones, and pointed anterior extremity. Hall obtained his specimens from the shaly intercalated layers in the central part of the Trenton limestone at Middleville. (Group 7)

WHITELLA Ulrich

Whitella ventricosa Hall *sp.*

Edmondia ventricosa Hall. Pal. N. Y. 1847. 1:155

A single large specimen of this species was found in a pebble of black compact limestone. Edmondia ventricosa is said by Hall to occur in the central and higher part of the Trenton limestone at various localities of New York. White reports it also from the Black river beds of the Poland limekiln section. Its occurrence in the west is still doubtful. (Group 5)

CTENODONTA Salter

Ctenodonta ? *sp.*

A single cast of a lamellibranch was found on a black compact limestone pebble, which in its outline is suggestive of a Cleidophorus, but it lacks the preumbonal clavicle impression, and probably belongs to a Ctenodonta of the C. nasuta group. It is too incomplete to allow exact determination. (Group 5)

Ctenodonta *cf.* astartaeformis Salter

There were also found three specimens of a small Ctenodonta of the C. (Nucula) levata group, which are comparable to C. astartaeformis Salter, of the Canadian Trenton,[1] but, judging from the description and figure of that species, seem to differ from that by being wider anteriorly and having very strongly developed growth varices which give to their surface

[1] Can. organic remains. 1859. Decade 1, p. 39.

an undate appearance. This feature is shown by all specimens, and is, therefore, evidently quite constant. It constitutes a specific difference from other species of Ctenodonta, of which C. similis Ulrich, from the upper Lorraine beds of Minnesota, is evidently very similar in outline, character of beak, etc. to the form from Rysedorph hill. As, however, the internal characters have not been elucidated, the description of the species is properly deferred till more complete material can be obtained. (Group 5)

GASTROPODA

PROTOWARTHIA Ulrich

Protowarthia cancellata Hall *sp.*

Bellerophon bilobatus Hall *non* Sowerby. Pal. N. Y. 1847. 1:184

Bellerophon cancellatus Hall. Pal. N. Y. 1847. 1:307

The fossil referred by Hall to Bellerophon bilobatus Sowerby occurs quite frequently in well developed specimens in the black compact limestone pebbles. Ulrich, maintaining that the American and the European form are specifically distinct, doubts whether the latter occurs in America, though its name has entered so largely into the American geologic literature; and, as he believes that Hall's B. bilobatus from the Trenton and Lorraine beds is identical with the same author's B. cancellatus from the Lorraine, he applies the latter name to this important Trenton form, making it at the same time the type of a new genus. Some of the specimens of the Rysedorph hill conglomerate by their more angular beak and the outline of the apertural lobes approach forms which formerly were also referred to B. bilobatus, but have been separated by Ulrich as Protowarthia rectangularis.

Bellerophon bilobatus was known to Hall only from the Trenton, Utica and Lorraine beds of New York. It possesses the same range in Canada, while in the west it has been found to appear in the Black river beds and to rise above the Lorraine into the Richmond beds. (Group 5)

CONRADELLA Ulrich & Scofield

Conradella compressa Conrad *sp.*

Phragmolites compressus Conrad. An. geol. rep't. 1838. p. 119

A few specimens of this handsome and striking fossil were found in gray crystalline limestone pebbles of the Moordener kill conglomerate, and black compact limestone pebbles of the Rysedorph hill conglomerate. The specimens do not show any marked difference from the typical material of this species in the New York state museum, nor any approach to any of the western species of this genus described by Ulrich. In New York this form is known only from the Trenton limestone. (Groups 5, 7)

CARINAROPSIS Hall

Carinaropsis carinata Hall. Pal. N. Y. 1847. 1:183

In a pebble of compact black limestone of the Rysedorph hill conglomerate a large Carinaropsis was found associated with numerous cranidia of a Remopleurides, which in profile and outline, and specially in the largely expanded aperture, and the sudden contraction toward the small incurved apex fully agrees with Carinaropsis carinata Hall, slightly differing in that the carination becomes obsolete near the apertural margin. Several smaller specimens of this rare species were found in the gray crystalline limestone, and in the compact reddish gray limestone a large specimen with very sharply projecting carina and strong concentric corrugations around the aperture. Hall reports this species from the black compact limestone at Middleville and Trenton Falls; while later collectors of Trenton fossils in this state make no mention of it. In the west the genus is represented in the Trenton group by several other species. (Groups 5, 6, 7)

LOPHOSPIRA Whitfield

Lophospira bicincta Hall *sp.*

Murchisonia bicincta Hall. Pal. N. Y. 1847. 1:177

Several casts of large specimens showing distinctly three carinations on the last whorl and the bicarinate upper whorls,

characteristic of this species, were found in the gray crystalline limestone pebbles and in a pebble of compact black limestone. In New York this species is also known from the Trenton beds; in Canada, the west, and the Cincinnati region, it has, however, been found to have its inception in the Stones river beds (Lowville limestone) and to pass through the Black river beds. (Groups 5, 7)

Lophospira perangulata Hall *sp.*

Murchisonia perangulata Hall. Pal. N. Y. 1847. 1:179

In the gray crystalline limestone pebbles a number of internal casts were found, which in the angularity of their volutions can be compared only with Murchisonia perangulata Hall, first described from the Lowville (Birdseye) limestone and in a supposed variety also from the lower Trenton of Middleville. Ulrich and Scofield hold the opinion that the two forms, united by Hall under one specific designation, represent in reality two different species, and refer a form from the western Stones river group to the Lowville type of M. perangulata. While the specimens from the Rysedorph hill conglomerate are a little more slender than Hall's type specimen apparently was, they all agree in the apical angle with some of the specimens figured from the Stones river group, and it is thought that they come nearer to the Lowville than to the Trenton form. (Group 7)

LIOSPIRA Ulrich & Scofield

Liospira americana Billings *sp.*

Pl. 2, fig. 7

Pleurotomaria americana Billings. Can. nat. and geol. 1860. 5:164

Pleurotomaria lenticularis Emmons, Hall and others (*non* Sowerby)

In a pebble of black compact limestone collected at Rysedorph hill, a large gastropod, somewhat weathered on the surface was found, which in outline and profile fully agrees with the Trenton form described by Emmons and Hall as Pleurotomaria lenticularis, these authors regarding it identical with Sowerby's Trochus jenticularis. Billings, recognizing the dif-

ference between the American and the European forms, described the form as Pleurotomaria americana. As Ulrich has pointed out lately, some other of Billings's species have been currently referred to Pleurotomaria lenticularis, viz P. vitruvia and P. progne. Both of these, when only casts are at hand and the surface characters are obliterated, can still be distinguished from the large Liospira americana, as the same investigators have demonstrated, by the character of the umbilicus. Liospira vitruvia and americana having an open umbilicus, while that of Liospira progne is closed. Liospira vitruvia and americana can be distinguished in sections by the angular margins of the umbilicus and its flattened sides in the former; the margins and sides of Liospira americana being round. A drawing of a section of the Liospira found in the Rysedorph hill comglomerate has been given; it shows that by the character of its umbilicus it can be referred only to Liospira americana.

Mr Ulrich has separated such species as Pleurotomaria americana, which are distinguished by their sublenticular shell, low depressed spire, almost smooth surface and subrhomboidal volutions, as Liospira The section figured shows distinctly the subrhomboidal section of the volutions as well as the depressed conic form of the shell. The *Paleontology of New York*, v. 1, reports this species from various Trenton localities, stating that it is most common in the higher crystalline portions of the rock at Watertown. Dr White cites it also from the Black river beds at Rathbone and West Canada creeks, and Prosser and Cumings[1] also found a form, doubtfully referred to this species, in the Black river beds near Newport. In Canada, Tennessee and the Cincinnati region, it has, however, been found in beds corresponding in age to the Lowville limestone. Its geographic distribution is great, for it has been found at Silliman's Fossil Mount in Baffin Land, is reported by Dr Whiteaves[2] from the Trenton beds of Lake Winnipeg and occurs in Minnesota and Tennessee.

[1] N. Y. state geol. 15th an. rep't 1898. 1:631.

[2] Pal. fossils. 1897. v. 3, pt 3, p. 191.

Liospira subtilistriata Hall *sp.*

Pleurotomaria subtilistriata Hall. Pal. N. Y. 1847. 1:172

This characteristic small, lenticular gastropod was found in great abundance in the gray limestone pebbles of Rysedorph hill. At the time of the publication of the first volume of the *Paleontology of New York* Hall knew this species only from the concretionary limestone near the base of the Trenton at Watertown. Dr White did not observe it in the Trenton Falls section and the other localities along the West Canada creek, nor has he reported it yet from the Lake Champlain region. As it is mentioned neither by Ulrich and Scofield from Minnesota and the western states nor by Dr Whiteaves from Lake Winnipeg, nor by Schuchert from Baffin Land, it is evidently a form of horizontally and vertically restricted distribution and quite probably of some taxonomic value, indicating a low Trenton horizon. (Group 7)

CLATHROSPIRA Ulrich & Scofield

Clathrospira subconica Hall *sp.*

Pleurotomaria subconica Hall. Pal. N. Y. 1847. 1:174

A few small specimens showing the characteristics of this species well developed were obtained in the gray crystalline limestone pebbles. Hall, in describing the species, had specimens from the lower part of the Trenton limestone at Watertown and from the Lorraine shales at Turin and Pulaski. In Canada it occurs also in the Black river beds, and in the west it is found in the Stones river group.

Ulrich and Scofield have described a very similar western form, C. conica, which is considerably smaller than C. subconica, and hence is said to have often been confused with young specimens of that species. The specimens from Rysedorph hill, though also much smaller than the average specimens of C. subconica, failed to agree with C. conica in other differentials from C. subconica. (Group 7)

ECCYLIOPTERUS Remelé

Eccyliopterus spiralis *sp. nov.*

Pl. 2, fig. 9, 10

A species of Eccyliopterus found in a pebble of black compact limestone from the conglomerate of the Moordener kill and associated with cranidia of Pterygometopus callicephalus and with Plectambonites pisum differs from its three Trenton congeners in being very loosely coiled. It may therefore be described here as new, though as yet known only by a single somewhat imperfect specimen.

Whorls strongly evolute, lying nearly in the same plane, apparently not more than two in number; enlarging quite rapidly, more in hight than in width. Upper side of shell marked along the outer margin by a carina extending into the collar, characteristic of Eccyliopterus; upper side sloping concavely inward, outer side nearly vertical, slightly convex; under side strongly convex. The collar is only partially preserved, its hight and extent therefore unknown. Aperture nearly vertical to the plane of the shell, ovate. Faint close growth lines are noticeable on the under and outer side of the specimen.

Dimensions. Length 35.2 mm, greatest width of volution 9.4 mm, greatest hight 10.8 mm.

Observations. This species may be easily distinguished from Eccyliopterus (Ophileta) ottawensis Billings, from the Canadian Trenton; from E. (Ophileta) owenanus Meek and Worthen, from the Trenton of Minnesota, as well as from E. beloitensis Ulrich and Scofield, from the Stones river group of Wisconsin and Kentucky, by its evolute and loose instead of contiguous whorls. In this regard as well as in the section of the whorls it is more related to E. (Eccyliomphalus) volutatus Whitfield, from the Fort Cassin beds, from which it differs in having a straight mouth, and considerably more rapid enlargement of the volutions. (Group 5)

TROCHONEMA Salter

Trochonema umbilicatum Hall *sp.*

Pleurotomaria umbilicata Hall. Pal. N. Y. 1847. 1:175

A pebble of gray crystalline limestone from the Rysedorph hill conglomerate was found to be filled with specimens which in all essential features agree with the descriptions of Trochonema umbilicatum given by Hall, Salter, Ulrich and Scofield, with the slight exception that the space between the suture and the first carina is not as flat as in most specimens, but rather concave. The carinae are more distinct than in any specimen figured by Hall. This form possesses a great vertical range, from the Lowville limestone to the Lorraine beds, and wide geographic distribution, being reported from Baffin Land, Lake Winnipeg, New York and the Trenton of the Mississippi basin. (Group 7)

HOLOPEA Hall

Holopea paludiniformis Hall. Pal. N. Y. 1847. 1:171

A large internal cast of this rare species, of which Hall reports that he obtained only one specimen (also a cast) from the crystalline upper part of the Trenton limestone at Watertown, was found in a pebble of compact black limestone at Rysedorph hill. Our specimen differs slightly from the type in having the volutions a little less ventricose and in its umbilical perforation. The form is not mentioned by later collectors with the exception of Ulrich and Scofield, who have referred a species from the lower Trenton in Minnesota to this species. This also is said to have a small umbilical perforation. (Group 5)

CYRTOSPIRA Ulrich

Cyrtospira attenuata *sp. nov.*

Pl. 2, fig. 8

A single specimen of Subulites was found in the gray crystalline limestone, which by its strong curvature is of a striking appearance to the eye accustomed to the rigidly erect species of the New York forms of Subulites.

Diagnosis. Shell small, length 12 mm; consisting of about five volutions, the last one of which occupies three fifths of the entire length of the shell; the four apical volutions are nearly straight, but the body whorl is curved in such a way that the apertural side appears straight, while the opposite side forms in outline a regular arch, the hight of which, measured in the middle, is a little greater than the width of the shell. Apical angle 38°; greatest width of valve between one third and one fourth of the length.

Aperture not observed.

Ulrich has separated species in which the aperture exceeds one half the whole hight of the shell, the shell arcuate and the truncation of the lower extremity of the aperture not so apparent, from Subulites and united them under the new generic designation, Cyrtospira. Our species shows the first two generic characters of this new genus in a marked degree, and stronger than the type species, while the third, the character of the aperture, is not observable.

This species differs from other congeneric forms, notably from C. parvula Billings from the Black river beds, C. abbreviata Hall from the Trenton of New York, and the three species described from the western Stones river and Trenton beds, in its longer spire, more slender form and stronger curvature. (Group 7)

PTEROPODA

HYOLITHUS Eichwald (ORTHOTHECA Novák)

Hyolithus rhine *sp. nov.*

Pl. 2, fig. 12–15

Among the novel forms of the Rysedorph hill fauna is a specimen of Hyolithus, obtained from the reddish gray compact limestone.

Diagnosis. Form, an elongated triangular pyramid, tapering at an angle of 16°; transverse section broadly triangular; ventral face slightly convex; dorsal face roof shaped with subangular crest; sides toward the aperture very slightly convex, toward the apex, however, bearing a broad, shallow, longitudinal depres-

sion, occupying about half the width. Lateral angles subacutely angular. Aperture unknown, but judging from the closely crowded growth lines, which curve forward on the dorsal side more than on the ventral, the peristome can hardly have arched forward on the ventral side, but probably was more or less abruptly truncated (subgenus Orthotheca Novák) Operculum unknown.

Dimensions. Length 35 mm or more, width 10+ mm, hight 6.4+ mm.

Observations. Only one other species has been made known from the Trenton, Hyolithus baconi Whitfield[1]. The Rysedorph hill species differs from this in tapering less rapidly, having a more elevated dorsal side (according to the lateral view given of H. baconi), and the growth lines on the convex side arch forward instead of passing straight across. It is noteworthy that only two species of this genus have thus far been found in the rich Trenton faunas from various regions of the continent. The distribution of this genus in the American beds seems to furnish an instance of the intermittent appearance of a group of organisms; for Hall[2] cites no less than nine species from the Cambric and six from the Devonic beds, with only one species to fill the tremendous interval from the Potsdam to middle Devonic beds. Since Hall's publication the number of North American Cambric species has increased to 14, and that of the Devonic to 11, while one species has become known from the Chazy, one from the Trenton, one from the Lorraine, and one from the Niagara beds. Nor can it be held that one of the two subgenera into which the genus has been divided by Holm comprises the Cambric and the other the Devonic species, thus resolving the apparent twofold culmination of the genus into the culmination of two different successive groups of fossils. That the genus Hyolithus is also represented in other localities within this state becomes apparent from Dr White's investigations of the Trenton Falls section, whence he

1 Geol. Wis. 1882. 4:225.
2 Pal. N. Y. 1879. v. 5, pt 2, p. 197.

cites an undescribed species of Hyolithus from two horizons.[1] (Group 6)

HYOLITHELLUS Billings

Hyolithellus micans Billings. Can. nat. 2d ser. 1871. 4:215

Pl. 2, fig. 11

The highly characteristic internal cast of the operculum of this species, showing very distinctly the subcentral knob and the radiating elongate ovate scars and smooth margin, was found in a limestone pebble from Rysedorph hill, differing from the rest of the limestone pebbles in lithologic appearance. The specimen retains a part of the periderm and a fragment of the shell and this indicates, as the appearance of the limestone would suggest, that the lower Cambric conglomerate limestone of Troy, a few miles to the north, which contains this problematic fossil in considerable number, is very sparingly represented in the Rysedorph hill conglomerate. This older Cambric conglomerate has also been found by Ford at Schodack Landing, with Hyolithellus micans and other species, and has, therefore, a similar extension as the Trenton limestone conglomerate, with which it strikes parallel but farther east on the other side of the overthrust fault. As we shall presently observe, the Trenton conglomerate limestone is similar in other features to the Cambric limestone at Troy and indicates a repetition of the conditions of early Cambric time, in the lower Siluric of the same region. (Group 1)

CONULARIA Miller

Conularia *cf.* **trentonensis** Hall. Pal. N. Y. 1847. 1:222

A very young specimen of Conularia was found in a black limestone from the Moordener kill conglomerate. It shows only the transverse ridges; the direction and the strong development of these, however, are very suggestive of identity with Conularia trentonensis Hall. (Group 5)

[1] N. Y. acad. sci. Trans. 15:94.

CEPHALOPODA

SPYROCERAS Hyatt

Spyroceras bilineatum Hall *sp.*

Orthoceras bilineatum Hall. Pal. N. Y. 1847. 1:199, 300

Hall described and figured as Orthoceras bilineatum a shell which Dr Emmons had collected at Rysedorph hill. Whether the specimens have been found in the matrix or in the pebbles, and in which kind of the latter, can not now be established. The writer has not observed any specimens of this species in the conglomerates of the localities investigated.

Spyroceras *cf.* anellus Conrad *sp.*

Orthoceras anellus Conrad. Acad. nat. sci. Phil. Proc. 1843. 1:334

In the gray crystalline limestone thin and very slightly tapering fragments of a cephalopod are found, which are characterized by sharply elevated, equidistant, longitudinal ridges with smooth interspaces. Forms with a like surface sculpture, but with much less rapidly tapering shells, have been described by Hall from the Beekmantown and Trenton beds as Orthoceras laqueatum. Dr Clarke has shown[1] that the shell of O. bilineatum is not annulated in the apical region, but is quite strongly marked by alternating longitudinal elevated lines, which as growth advances become finer, while strong annulations gradually develop. These features bring O. bilineatum under the genus Spyroceras of Hyatt. From this fact it seems probable that Hall's O. laqueatum is only the apical portion of a Spyroceras, probably O. bilineatum. The specimens from Rysedorph hill show only equal longitudinal ridges, but as they represent much younger growth stages than those observed by Clarke—they have a diameter of only 1 to 2 mm—it might be inferred that they also belong to Spyroceras bilineatum, and that the finer intercalated, longitudinal ridges develop only with later growth. This conclusion

[1]Geol. Minn. Pal. 1897. v. 3, pt 2, p. 786.

would seem to be supported by the finding of a specimen of S. bilineatum in the Rysedorph hill conglomerate by Dr Emmons. There are, however, some facts which combat such a view. These are the observations of Clarke; that the alternation of the striae is more distinct toward the apical region and by rapid intercalation becomes less pronounced toward the aperture; farther, that a shell of S. bilineatum, with a diameter of 7 mm, had only 12 lines of the first order, while the shells under consideration, with a diameter of only 3 mm, have already about 20 striae; that no trace of the fine transverse lines, appearing on all stages of S. bilineatum, has been observed thus far; and finally that the small shells of Rysedorph hill taper exceedingly slow, while those of S. bilineatum taper quite fast. A fragment ¾ inch long shows no measurable increase in diameter. Orthoceras anellus Conrad differs in just these features from O. bilineatum and it suggests itself that these shells, if not a new species, are very likely to be the apical portion of O. anellus, hitherto not observed, and also that O. anellus is a typical Spyroceras.

Spyroceras bilineatum has been found to range in the east (Canada) from the Black river into the Trenton beds, in the west to begin in the Stones river beds, and Spyroceras anellus begins in the Black river beds and extends into the Trenton. (Group 7)

(Cyrtoceras) subannulatum d'Orbigny *sp.* Prodr. de pal. 1850. 1:1

Cyrtoceras annulatum Hall. Pal. N. Y. 1847. 1:194

A fragmentary specimen characterized as belonging to Cyrtoceras annulatum by its strongly arcuate annulations, fine transverse lines and central tubular siphuncle, was found in a pebble of greenish gray compact limestone. This species was obtained by Hall from the lower and upper Trenton beds of New York. (Group 7)

ZITTELOCERAS Hyatt

Zitteloceras hallianum d'Orbigny *sp.*

Cyrtoceras hallianum d'Orbigny. Prodr. de pal. 1850. 1:1

Cyrtoceras lamellosum Hall. Pal. N. Y. 1847. 1:193

In the black limestone, fragments of Cyrtoceras hallianum were found with the undulating squamous lamellae characteristic of this species. Hall knew this species only from the lower part of the Trenton limestone at Middleville, and later collectors do not mention it. Dr Clarke reports it from the Black river beds of Wisconsin and Minnesota. (Group 5)

CRUSTACEA

TRETASPIS McCoy

Tretaspis reticulatus *sp. nov.*

Pl. 3, fig. 11, 15–20

Several pebbles of black compact limestone were found to be filled with a trinucleid, representing the genus Tretaspis which is new to this hemisphere. The specimens, about 20 of which were obtained, occur in association with Ampyx hastatus, Illaenus americanus, Ceraurus pleurexanthemus, Sphaercoryphe major, Cyphaspis and plates of a Glyptocystites.

Diagnosis. *Cranidium* subrectangular to semicircular in outline, the former in younger specimens; length to width as 3:8; frontal margin slightly rounded to nearly straight. Glabella pyriform with the anterior part spheric, abruptly widening and rising above the neck of the glabella; frontal part reaching to and slightly overhanging the frontal border; posterior part of glabella narrow, angular and provided with a median crest extending from the occipital ring to about the middle of the frontal lobe, where it ends with a tubercle. There are three pairs of deep pits or fossae; the first small, deep and round, well up the tumid part of the glabella; the second broad and oval extending obliquely forward from the dorsal furrow; the third deep, transverse impressions situated a little anteriorly of the occipital furrow.

Dorsal furrows distinct, broad and deep, narrowing forward and extending to the frontal border. Fixed cheeks slightly prominent, trapezoidal in outline, nearly flat in the middle part and bending rather abruptly into the dorsal furrow and to the marginal border; each cheek provided with an "eye line," which, arising in the dorsal furrow below the first glabellar pit, extends in the direction of the genal angle, culminating near the middle of the cheek in an eye tubercle and becoming then indistinct. Occipital furrow broad and shallow, widening on either side of the glabella. Occipital ring a uniformly narrow ridge which in the axial lobe rises to a semicircular plate (base of spine?).

Surface of glabella coarsely pitted; cheeks pitted along the border and strongly reticulate in the middle. The meshes of the reticulation are largest on the cheeks; dorsal furrows and occipital ring smooth. Marginal border in front of the glabella inclined to base at an angle varying between 80° and 90°, but becoming less inclined posteriorly; in front of the cheeks for about half of its width moderately convex, then equally concave with the margin upturned. The convex portion of the border in front of the glabella is occupied by four concentric rows of circular funnel-shaped perforations, which posteriorly increase by interplantation to seven or more rows; the concave portion bears a row of radiating elongated perforations[1]; the rows of perforations are separated by filiform, strongly projecting concentric ridges, which toward the genal angles become less distinct.

Free cheeks not observed.

Thorax not well preserved, apparently consisting of six segments, axis broad, moderately convex, decreasing in width more than one third; axial grooves shallow; pleurae not observed.

Pygidium roundish subtriangular, with an axis in a small specimen that is broad at the beginning, slightly tapering and ending bluntly; more acutely tapering in larger specimens; the small

1 Dr D.-P. Oehlert has demonstrated in his valuable paper entitled: Sur les Trinucleus de l'Ouest de la France (Soc. géol. de France. Bul. 3e série. 1895. 23. p. 289) that the apparent perforations of the limb of Trinucleus are only the result of an unfavorable preservation; and that, in fact, the limb or doublure of Trinucleus is imperforate, but possesses cavities, produced by the invagination of the tegument of the limb. As the tegument mostly fails of perfect preservation, these double-conical cavities appear opened at their dorsal and ventral apexes.

specimen shows seven, the large nine annulations; only faint indications of pleural grooves on the nearly smooth, almost flat sides; margin beveled, concentrically striated.

Dimensions. Width of cranidium 13 mm, length 6 mm, greatest width of glabella 3.4 mm.

Horizon and locality. Nearly all specimens were obtained from two small pebbles of black compact limestone, where they were associated with Trenton fossils. (Group 5)

Observations. This species differs too obviously from the common Trinucleus concentricus and the similar Trinucleus bellulus to necessitate a long exposition of these differences; as most striking may be mentioned, the glabellar fossae, the tubercles, the eye line, the structure and profile of the marginal border, and the pitted reticulate surface of the cheeks and glabella. While this species differs so markedly from other American species, it shows the closest similarity to a group well known in Europe, the typical form of which is T. seticornis Hisinger, which in the fuller discussion given to this form and its characters by Nicholson and Etheridge[1] is shown to exhibit at the best only varietal differences from T. bucklandi Barrande. By Roemer and Frech the latter species is united with T. seticornis. This species is specially characterized by the presence of the glabellar pits, the apical tubercle on the glabella and the ocular tubercles, the eye lines, the deep dorsal furrow and the structure and profile of the marginal border.

McCoy repeatedly (1849, 1851) proposed the subdivision of the genus Trinucleus into two subdivisions—Trinucleus proper and Tretaspis McCoy, the latter characterized by "the presence of five thoracic segments, the furrows on each side of the base of the glabella, a diagonal line crossing the cheeks, approximately occupying the position of the facial suture and usually a small apical or culminating tubercle ocular (?) in character." This subdivision was adopted by Salter in 1857, who thus defines Tretaspis McCoy; "Ocular tubercle distinct; eye

[1] Monograph Sil. foss. Girvan district in Ayrshire. 1880. Fasciculus 2, p. 190.

line cutting the posterior margin, but the head not separated at the suture; glabella lobed." Barrande protested strongly and repeatedly against the subdivision, principally on the following grounds: the eye line is not a suture but only a single nervure, as is visible in many other Trilobites; and the five segmented thorax is of no account because of the metamorphosis undergone by Trinucleus. Nicholson and Etheridge, after the examination of a great number of specimens, fully concur with Barrande as to the unimportance of the number of the segments and the presence of the eye line, and therefore conclude, that Tretaspis as proposed by McCoy or Salter can not stand, but at the same time hold, that it may be advantageous to retain the term for that section of the genus Trinucleus which possesses a lobed glabella.

Beecher has shown (Am. jour. sci. 1895. 49:307) that Trinucleus concentricus, in its adolescent stage, possesses the features pointed out by McCoy and Salter as characteristic of the genus Tretaspis, and on this ground is inclined to reject McCoy's divisions of the genus Trinucleus, as Barrande did.

The cephala here described as those of Tretaspis clearly agree with the cephala of the young individuals of Trinucleus concentricus, figured in Beecher's excellent paper, in possessing the so called eye-lines and eye-tubercles. While, however, that investigator states that these features disappear when a width of 5 mm is attained, they are still distinctly preserved in the specimen figured on pl. 3, fig. 18, which has attained a width of 13 mm, that is, nearly the average size of the specimens of Trinucleus concentricus, and shows mature development of the border. Furthermore, the specimens from Rysedorph hill have the pitting which is so distinct in the stages figured by Beecher, and which also, as a very fine pitting, is still present on the mature Trinucleus concentricus, accentuated into a coarse reticulation. Also in the relatively small size of the glabella and the apparent absence of genal spines these specimens retain adolescent features. On the other hand they fail to show any indications of the triangular areas

marked off from the cheeks on each side of the glabella in the young of Trinucleus concentricus; and the lobation of the glabella which in adult specimens of T. concentricus has become entirely obscured, but is faintly shown on the young, is, in the specimens in the writer's hands, distinctly developed (*see* pl. 3, fig. 18). It is this feature on which Nicholson and Etheridge would base the genus Tretaspis.

The specimens from Rysedorph hill, therefore, not only retain features characteristic of the early stages of T. concentricus to a mature or approximately mature size, but have certain of these features, notably the lobation of the glabella and the ornamentation of the cheeks even more strongly developed than those young stages. There can, therefore, be hardly any doubt that this form represents a phylogenetic stage in the development of the Trinucleidae, that is preceding Trinucleus proper and partly repassed in the ontogeny of the latter. It seems to the writer to be in full accord with our modern conception of a genus to recognize this distinct stage by a separate generic term. The features characteristic of this genus are also apparent in Angelin's species, Trinucleus bucculentus, (tab. 41, fig. 1) and T. foveolatus, while his T. affinis shows all these characteristics without the glabellar furrow, but his suggestion, "*an potius status juvenilis Trinuclei seticornis?*" would relegate this species into that group. Our species agrees fully with T. (Tretaspis) seticornis Hisinger, in the following features: the outline, surface sculpture and lobation of the glabella, the details of the marginal border with the exception that in T. reticulatus it is not bent vertically downward at the sides but only at an angle of about 45°. No important difference appears in the development of the thorax and pygidium. The principal differences would, then, seem to lie in the crest on the glabella, the less rounded and less convex profile and more trapezoidal outline of the cheeks and their strongly reticulated surface. We notice however that Angelin figures a form as T. affinis

which, as he suggests, might represent the young of T. seticornis, and which, judging from his drawings (specially tab. 40, fig. 21) shows a similar coarsely pitted and reticulate surface and similar outline of the cheeks. From all of these species, congeneric with Tretaspis reticulata, our form differs not only in the strong reticulation, but also in the development of a carina on the glabella of which no mention is found in the descriptions, and no indication in the illustrations of these species.

Angelin[1] however figures a form, T. carinatus, which has a median carina, passing along the whole length of the glabella, and which also belongs to the subgenus Tretaspis a fact which serves to prove that this feature also was represented on the other side of the Atlantic basin, and, as T. carinatus is supposed to come from *regio Da*, both carinate forms are approximately homotaxial.

Trinucleus seticornis occurs in Scotland and Ireland in beds referred to the Caradoc age, in Sweden in *regio Da*, and in Bohemia, at a horizon which lies higher than that to which belong even the Normans kill shale beds, in which the conglomerate bed containing this fossil is intercalated. Our form is, hence, older than all its congeners with the exception of T. bucculentus, from *regio Bà*, Norvegiae, the species which differs most from the rest of the group.

Tretaspis diademata *sp. nov.*

Pl. 3, fig. 12, 13, 14

A specimen of Tretaspis which was found in a black limestone pebble associated with Tretaspis reticulata and Ampyx hastatus presents the general appearance of the former except that in the limb the perforations are not arranged concentrically, but radially and so closely set as to produce high radial ridges and furrows. In the specimen the limb is present only as an internal cast, and the perforations appear

[1] Lindström's 2d ed. 1878. pl. 34, fig. 8.

therefore on the crest of the ridges. At the genal angle the ridges become rather abruptly dissolved into a crowded irregular mass of perforations (tubercles in the cast). Other differences between this and the preceding species are the considerably less width and almost vertical position of the limb in the frontal region and the greater prominence of the cheeks. The cheeks and glabella are finely reticulate.

Dimensions. Width of cranidium 15 mm; length 5.8 mm; greatest width of glabella 3.1 mm.

Horizon and locality. Pebble of black limestone in Rysedorph hill conglomerate. (Group 5)

Observations. The writer was at first inclined to consider this form as only a variety of T. reticulata. As, however, forms differing from T. seticornis in the same development of the limb have been described from corresponding beds in Norway and Great Britain, it seems opportune to separate also this form, in order to emphasize the fact of the occurrence of this type together with that of T. reticulata in approximately homotaxial beds on this and the other side of the Atlantic. It is, however, to be noted that, both in T. seticornis and T. reticulata, the perforations show more prominent arrangement in concentric rows, and less distinct radial arrangement; hence these forms probably represent only diverging branches from the principal stock, the common and widespread T. seticornis in Europe and T. reticulata in America. Angelin's form T. foveolatus (pl. 41, fig. 2) is from Da Norvegiae, and described as follows: *T. capite subtiliter favoso, limbo radiato, fronte utrinque foveolis (?), apice subglobosa, punctis ordinariis majusculis.* In this form the radial arrangement of the perforations extends over the whole surface of the limb. A corresponding form occurs in the Llandeilo and Caradoc beds of Great Britain, and was first described by Murchison as Trinucleus fimbriatus (?); later its characters were elucidated more fully, and a complete specimen from the Llandeilo flags figured by Sedgwick and

McCoy[1]. A comparison of the description and figure with our specimen shows a close similarity in the two forms, the limb in both being apparently alike, even to the breaking up of the radial rows into irregular arrangement at the lateral angles. The principal difference between the two species seems to lie in the shape of the glabella, which in the Trenton form is highly convex, with a hemispheric frontal part and an abrupt contraction to a narrow ridge behind the same, as in T. reticulata.

The posterior part of the glabella and cheeks are not so well preserved as indicated by the drawing.

AMPYX Dalman

Subgenus LONCHODOMAS Angelin

Ampyx (Lonchodomas) hastatus *sp. nov.*

Pl. 3, fig. 1–10, 30

The black compact limestone pebbles contain in great abundance cranidia and pygidia of a new species of Ampyx in association with such Trenton fossils as Pterygometopus callicephalus.

Diagnosis. *Cranidium* hastate in appearance, terminal points of glabella and fixed cheeks falling approximately into the angles of a regular triangle. Glabella subrhombic, contracted anteriorly and posteriorly, most convex and widest near the middle; more than half of it projecting snoutlike from the remainder of the cranidium; carina (or in others only a flattened area) extending the whole length of the glabella. Two long elliptic depressions, beginning in the pits at the base of the glabella, directly in front of the neck furrow, extend at the foot of either slope of the glabella for about one fourth of its length; two others directed obliquely downward, lie at the anterior ends of the dorsal furrows at the point where glabella and fixed cheeks meet exteriorly; two more lie directly above the others and are parallel to the axis of the glabella. On casts of the glabella (pl. 3 fig. 7) two prominent, transversely elliptic elevations can be noticed directly in front of the neck ring. On the crust they

[1] Syn. of classif. of Brit. pal. foss. 1855. pl. 1 E, fig. 16.

appear faint projections. It is supposed that they represent muscle scars.

Rostrum very long, prismatic, with a subrhombic section, upper sides grooved; strongly bent upward. Fixed cheeks having the shape of slightly recurving cusps, moderately convex, sloping rather abruptly downward at the frontal margin and gently upward in front of the neck segment, lying ventrally with their frontal part below the middle of the glabella, where a narrow, flat, vertical rim is developed. A line which appears most distinctly in casts as a narrow ridge, passes from the posterolateral angle of the fixed cheek obliquely forward across the same in the direction of the anterior glabellar pits. This line, in its direction and extent, seems to be an exact homologue of the eye line of Tretaspis and other trilobites and probably indicates the former presence and situation of the eyes in this genus, of which only blind forms are known. Suture line beginning directly below the second pair of glabellar pits, at the end of the flat marginal rim, running first a short distance outward, then turning rather abruptly backward to a point near the neck furrow, where it again curves outward, intersecting the occipital ring in oblique direction. Free cheeks were not observed, but, from the direction of the suture line, it is supposed that they were rather small, subtriangular plates. Dorsal furrows strongly marked. Neck furrow slightly curved, faint, deeper toward the genal angles. Surface of cranidium entirely smooth.

Thorax not observed.

Pygidium broadly triangular; axis well defined, broad, occupying about one third of the width of the plate, tapering slightly and ending bluntly near the terminal point; depressed convex, highest in the middle. Rarely more than six annulations, indicated by faint transverse furrows. Pleurae level, smooth, without indications of pleural ribs, with a deep furrow running parallel to the anterior margin, nearly vertically beveled along the margins, the upper edge of the bevel with an acute linear rim, sides finely striated parallel to the margin.

Dimensions. Width of cranidium 14.2 mm, length to base of rostrum 7.5 mm, width of glabella 5.2 mm, width of largest pygidium 5.5 mm, length 2.5 mm, width of axis 1.8 mm.

Horizon and locality. In the black compact limestone pebbles of Trenton age, in the conglomerate of Ryserdorph hill. (Group 5, 6)

Observations. This form differs from the only other Trenton species, Ampyx americanus Safford and Vogdes,[1] in the large anterior extension of the glabella beyond the fixed cheeks, this being a longifront, the other a brevifront, using subdivisional terms proposed by the discoverer of Ampyx americanus, and in having a strongly convex glabella without the oblique furrows of the western Trenton form. Our species is much more similar to Ampyx halli Billings, from the Chazy limestone of Canada and Vermont, with which it has in common the elongate convex rather strongly carinate glabella and the shape of the neck segment, but from which it differs in having a relatively shorter glabella extending hardly beyond the fixed cheeks, and by the semioval pygidium with distinct pleurae. Ampyx normalis from the Canadian Quebec beds, has the fluted rostrum and the rounded glabellar pits, but differs from A. hastatus in its short glabella. The Rysedorph hill species is much more closely similar to Ampyx rostratus Sars (Ampyx sarsii Portlock) in general outline, keeled glabella, long rostrum, long corniform cheeks, and according to the detailed description by Pompecki,[2] the elliptic impression on either side of the base of the glabella, while it differs in having the cheeks relatively broader and less contracted in the anterior part, and the pygidium more rounded. This closely related form is described by Portlock (loc. cit. p. 258) from the fossiliferous schists of Tyrone (Ireland) which are regarded as older than the schists with Diplograptus pristis and Graptolithus sagittarius, corresponding to our Normans kill shales in which the conglomerate is interbedded. Angelin describes the same species from the "*regio Da Norvegiae prope Christiania et in monte Kinnekulle Vestrogothiae*"; and

[1] Acad. nat. sci. Phil. Proc. 1889. 4:166.

[2] Trilobiten fauna der Ost- und Westpreussischen Diluvialgeschiebe. 1891. p. 16.

Frech (tab. p. 77) gives as its habitat the *Knollenkalk* $a\beta$ and $a\delta$ which are synchronous with the Glenkiln shales (Normans kill shales) and the corresponding lower middle graptolite shales of Scania and of Norway. Another European form with carinate glabella is Lonchodomas carinatus, which however has a more elongate cranidium, and is found in another horizon (Chasmops-Kalk of Westrogothia) according to Remelé.

The subdivisions of Ampyx, proposed by Forbes and Angelin, have been fully discussed by Nicholson and Etheridge,[1] and lately by Vogdes.[2] To restate shortly a case repeatedly elucidated, the genus Ampyx proposed by Dalman was divided in 1849 by E. Forbes[3] into:

1 Ampyx (Dalman) proper, with the head long and five segments of the thorax.

2 Brachampyx Forbes, 1849, with the head short and round and six segments to the thorax.

Dr Angelin in 1854[4] proposed the subdivision of his family into three genera:

1 Lonchodomas Angelin, with a lanceolate glabella, terminating in an elongate prismatic spine. Type L. (Ampyx) rostratus Sars.

2 Ampyx Dalman, with an oval glabella, terminating in a round spine, and six thoracic segments. Type Ampyx costatus Broeck.

3 Raphiophorus Angelin, with an obovate glabella, having an abrupt apical spine, and five thoracic segments. Type R. setirostris Angelin.

It appears by a comparison of these subdivisions, that Angelin retained the term Ampyx for forms with six segments, and thus applied it in the sense of the originator of the term, Dalman, who described Ampyx as having six segments; while Forbes proposed his term, Brachampyx, for just such six segmented forms. Nicholson and Etheridge, therefore, seem

[1] Monograph Sil. foss. Girvan district in Ayrshire. 1880. p. 178. ff.
[2] Am. geol. 1893. 11:99.
[3] Geol. sur. Gt. Br. Mem. Dec. 2, 1849. pt 10, p. 8.
[4] Pal. Scandin. p. 80.

to be fully justified in adopting Angelin's subdivisions in preference of the older ones of Forbes, on the very reasonable ground that the section represented by the original name of the author should correspond as nearly as possible to that author's definition. These subdivisions have also been adopted by other European writers on lower Siluric trilobites. A. W. Vogdes arranges the genus in three sections, as follows: 1) Brevifrontes, type Ampyx nudus Murchison; 2) Longifrontes, type Ampyx nasutus Dalman; 3) Lonchodomas, type Lonchodomas domastus Angelin.

It is evident that the species from Rysedorph hill falls under the section Lonchodomas of Angelin and Vogdes.

One pygidium (pl. 3, fig. 30) proved by its mode of preservation to be of exceptional interest. The crust of the axis is so favorably broken away that a perfect cast of the inferior surface is exposed. This exhibits, rising from the perfectly smooth surface of the matrix, two series of paired elevations which must correspond to impressions on the under surface of the crust. The outer series consists of the larger elevations, which near the anterior margin are round, largest, but also least projecting, while toward the posterior end of the axis they become smaller, transversely oval, being directed obliquely outward and forward, and more elevated and distinct. Alternating with this series is another of small, round tubercles, and within this lies still a third series of small tubercles, one always lying opposite the second, fourth, sixth, etc. of the inner second series. Along the median line runs a slightly elevated ridge corresponding to a median furrow of the pygidium. In another pygidium, in which the removal of the crust brought to light a similar system of elevations, eight of these could be counted in the exterior series. On the anterior part of the axis the annulation is indicated by a few shallow transverse grooves. These fall between the inner tubercles, and hence the elevations correspond with the annulation and original segmentation of the pygidium.

A series of tubercles similar to the exterior series has been described and figured by Nicholson and Etheridge[1] from the

[1] Monograph Sil. foss. Girvan district in Ayrshire. 1880. Fasciculus 2, pl. 13, fig. 3.

pygidium of A. rostratus Sars. These authors describe the axis of the pygidium of that species as faintly segmented and with a row of tubercles on each side. As the English species is in all features very closely related to that from the Trenton, and the latter never shows any tubercles on the axis of the external crust, but only on the casts, the writer feels sure that Nicholson and Etheridge had only casts of the pygidium, and based their conclusions on these. These authors, however, figure on pl. 10, fig. 20, of the same fasciculus a pygidium of an Asaphus *sp. ind.*, the slender axis of which, though much weathered, exhibits what appears to be a series of depressions on each side. Here the weathering has evidently reached the depressions in the crust, to which the above mentioned tubercles correspond. Similar depressions have before been observed by Salter[1] of Asaphus tyrannus, and considered by him to be internal glands, a view which evidently is also held by Nicholson and Etheridge. The writer has also obtained a small pygidium of Isotelus maximus from the Rysedorph hill conglomerate, which by the removal of the crust exhibits a series of eight pairs of tubercles which are somewhat obliquely directed backward (pl. 4, fig. 1).

The only observation of which the writer is aware which has been made on such pits in this country is that by Hall and Clarke[2] on a pygidium of Proëtus folliceps of the Onondaga limestone. In that specimen two paired series of alternating elevations can be observed; all of the elevations are however obliquely elongate, the inner series consists of the larger elevations, and the innermost elevations lie apparently directly on the axial line and are not paired. The same authors observed similar, though not so distinctly preserved markings on the internal cast of a pygidium of Proëtus crassimarginatus from the Onondaga limestone of Ohio[3] and the paired marginal impressions

[1] Monograph. pl. 22, fig. 9.
[2] Pal. N. Y. 1888. 7:101, pl. 29, fig. 1.
[3] Pal. N. Y. 1888. v. 7, pl. 25, fig. 8.

through the translucent crust of a pygidium of Phacops cristata var. pipa.[1]

Hall and Clarke consider the pits to be "areas of insertion for somitic muscles, the marginal pair probably connected with the natatory appendages, the axial pair possibly attached to the branchial apparatus, or to the viscera. The function of the median pits upon alternate grooves is not understood." On the upper surface of the crust of the Devonic species no indications of these characters were found. The axis of the pygidium of Ampyx is usually perfectly smooth or only provided with two or three faint annulations on the anterior part. One species, however (pl. 3, fig. 10) possesses a broad elevation along the median line of the axis; the indications of annulations, which in this species extend well toward the posterior end of the axis, are more distinct on the sides of the axis, than on the median elevation; the extent of this elevation, falling approximately in the region without distinct muscle scars, and the more distinct annulations on the sides, which probably are caused by the presence of the muscle scars, are indications of the influence of the strain exerted by the muscles on the configuration of the external crust.

REMOPLEURIDES Portlock

Subgenus REMOPLEURIDES *s. str.*

Remopleurides tumidus *sp. nov.*

Pl. 4, fig. 2–4

Two cranidia found in a pebble of dark gray, reddish weathering limestone (ostracode bed) differ so materially from the next described, Remopleurides linguatus, a form of most profuse occurrence in the black compact limestone pebbles, that they can not be considered to represent merely a later growth stage of the more common smaller species, but evidently represent a different type.

Diagnosis. *Cranidium* broadly elliptic, longest diameter at the posterior third; the longer diameter to the shorter as 10:9, poste-

[1] Pal. N. Y. 1888. v. 7, pl. 8 A, fig. 15.

rior margin nearly straight, lateral margin only slightly convex and curving but little inward to the base of the broad frontal lobe, which has straight margins, tapers only slightly and has a nearly straight frontal edge. Glabella moderately and regularly convex, highest at base of frontal lobe, from which it slopes regularly to the posterior and lateral margins and falls abruptly forward. Frontal lobe about one third the length of the cranidium. Glabellar furrows probably indicated by two pairs of barely visible, low, broad undulations near the posterior lateral margin, but not by smooth lines. Palpebral lobes very narrow, abruptly bulbous at the posterior angle. Surface of the cranidium smooth to the unaided eye, but not glossy on account of the presence of a microscopically small granulation; no striae observable. Occipital ring rather broad and wide, partly exfoliated in the type specimen.

Dimensions. Width of cranidium 9.6 mm; length to base of frontal lobe 7.9 mm; hight 3.2 mm.

Horizon and locality. In the reddish gray hard limestone pebbles at Rysedorph hill. (Group 6)

Observations. The glabella of this form shows a slight similarity in outline to that of R. striatulus Walcott, from the upper third of the Trenton limestone; it differs, however, by the absence of the coarse tuberculation and the suppression of the glabellar furrows, of which at least one pair is distinguishable in that species by smooth lines.

The cranidium appears to be more closely related to Remopleurides colbii Portlock, from the Caradoc, than to any other congener, but has also some relationship to R. affinis Billings, from the Quebec group.

Salter proposed to subdivide Remopleurides into two sections: one without glabellar furrows and inflated glabella, for which Portlock's original term, Remopleurides, was retained, and one with glabellar furrows and flat glabella, for which Barrande's name, Caphyra, was proposed.

Subgenus CAPHYRA Barrande

Remopleurides (Caphyra) linguatus *sp. nov.*

Pl. 3, fig. 21–29

The heads and pygidia of this species were found abundantly in the black crystalline limestone in association with Ampyx hastatus, etc. and in a few specimens also in the gray crystalline and reddish gray compact limestone pebbles of Rysedorph hill conglomerate.

Diagnosis. *Cranidium* transversely elliptic, longest diameter at the posterior fourth; longer diameter to the shorter as 9:8; strongly curved at the sides, rapidly contracting to the base of the frontal lobe, and to the junction with the occipital ring; base of frontal lobe and base of cranidium having about the same width; nearly flat, with a slight broad longitudinal depression in front of the occipital furrow; turning abruptly downward at the base of the frontal lobe; the latter tonguelike, half the length of the entire cranidium, straight in very young specimens, bending downward at an angle of 80° to 90° in mature specimens; with straight parallel or sometimes somewhat diverging margins; gently rounded forward. Three pairs of glabellar furrows distinctly indicated by curved, smooth linear depressions extending from near the margin three fourths of the distance to the median longitudinal depression. Palpebral lobes narrow, terminating bulblike posteriorly, encircling the cranidium from the base of the glabellar lobe to the occipital ring. Occipital furrow deep and narrow; occipital ring slightly convex, depressed below the level of the cranidium, short. Surface of cranidium with very fine, somewhat wavy transverse striae and tubercles; the latter increasing in size toward the lateral and posterior margins; anterior third of occipital furrow smooth with a small central tubercle; behind this two transverse filiform ridges and very large tubercles, obscurely arranged in four transverse rows.

Eyes large, forming an elongate crescent-shaped, rather high, nearly perpendicular wall with very finely reticulate, depressed convex surface.

Free cheeks narrow, beginning in front of the eyes with a vertical, rudderlike doublure of the outer margin (fig. 27) horizontal part forming a narrow, flat border around the eyes, which, on account of the strong curvature of the eyes and the outward and backward direction of its exterior margin, rapidly widens posteriorly into a subtriangular, slightly convex plate. Outer margin depressed, smooth, inner margin forming an elevated ridge supporting the eyes. Genal spines long, narrow, nearly flat, acutely pointed. Surface of free cheeks marked by finer striae directed obliquely inward and backward, becoming coarser on the spine and parallel to it.

A thorax referred to the same species has the features of the axis mostly obliterated by weathering, while the pleurae, which were buried in rock, are well preserved. The axis was apparently broad, about three times the width of the pleurae, regularly tapering posteriorly to a small pygidial plate quite strongly arched. The pleurae, 10 of which are found on either side, indicating the presence of 10 body segments, are only slightly bent at the beginning, but become increasingly falcate posteriorly, directed backward and downward with the exterior half, provided on the forward edge close to the axis with a strong, projecting fulcral tubercle, the opposite point of the hinder edge of the preceding pleura being furnished with a corresponding deep notch, the margin of which is raised all around. The pleurae are flat, with an oblique furrow extending from the fulcral tubercle to the tip of the point, and separating the deeper posterior part from the somewhat higher anterior, obliquely striated portion.

Of the pygidium only a small roundish plate is observable.

Dimensions. Width of cranidium 5.7 mm, length to base of frontal lobe 4.5 mm; of frontal lobe 2.3 mm; length of thorax 10+ mm, width of thorax 11+ mm.

Horizon and locality. Very common in the black compact limestone pebbles, rare in the reddish gray and gray limestone pebbles of the Rysedorph hill conglomerate. (Groups 5, 6, 7)

Observations. This form is very similar to some other American species, viz Remopleurides canadensis Billings, from the Canadian Chazy beds, and to the only other Trenton congener, R. striatulus Walcott, from the upper third of the Trenton limestone. With both it has in common the tuberculated cranidium, the presence of three pairs of smooth linear glabellar furrows and the central tubercle on the occipital ring. From both of these it differs in having the cranidium considerably broader than long, a longer tongue-shaped frontal lobe, in possessing fine striae, besides the tubercles on the cranidium, and by the strong tuberculation of the posterior part of the occipital ring.

From R. striatulus it also differs in the structure of the pleurae, which are here provided with distinct fulcral tubercles and corresponding notches and an oblique furrow, while those of R. striatulus are described as simply flat. In these features it agrees strongly with the species described from the Caradoc beds of Ireland by Portlock (emended by Salter) as R. colbii, laterispinifer and dorsospinifer.

In several features it seems to justify its intermediate stratigraphic position between the Chazy and the upper Trenton forms. Thus it resembles the former (R. canadensis) by the great relative width of its cranidium, and the latter by the character of the glabellar furrows. But the species from Rysedorph hill is still more similar to an Irish form, R. tuberculatus, lately described by F. R. C. Reed[1] from the Tramore limestone of county Waterford. With this it has the great width of the cranidium, the shape and extension of the abruptly projecting frontal tongue, the sudden increase in width of the palpebral lobes and the tuberculation of cranidium and neck segment in common. The Irish form differs in size, being about twice as large as R. linguatus and in the uniformity of its tubercles. It is also said to have but two pairs of glabellar furrows; as, however, some specimens of the Rysedorph hill species show but two or even but one pair of glabellar furrows, it is quite probable that more complete material of the Irish species would also show the third pair of

[1] Quar. jour. geol soc. 1899. 55:748.

furrows, and that this difference may easily be overestimated. It is of special interest that R. tuberculatus occurs in stages 2 and 3 of the Tramore limestone, which is said to underlie Glenkiln shales, homotaxial with the Normans kill graptolite shales.

There is still another European form which well bears a comparison with our fossil; this is Brachypleura sexlineata Angelin (pl. 9, fig. 13) which in relative length and width of glabella, character of eye lobes, specially at the posterior end, tuberculation of glabella and extent of glabellar furrows closely agrees with R. linguatus, while it differs in having a much narrower frontal glabellar lobe, and, judging from the drawing, in the absence of tuberculation on the neck ring. This species is from the limestone of the Kinnekulle in Vestrogothia.

ASAPHUS Brongniart

1 Subgenus ISOTELUS De Kay

Isotelus maximus Locke

2d an. rep't geol. sur. Ohio. 1838. p. 246

Cranidia, eyes, pygidia, hypostomata and large genal spines of this trilobite are extremely frequent in the gray crystalline limestone pebbles, in some parts so common as to exclude other fossils. They are less frequent in the black compact limestone pebbles and in the cement, and none has been found in the reddish gray limestone with ostracods. The numerous spines would indicate that the prevailing species is Isotelus maximus in distinction from Isotelus gigas, but, as Dr Clarke[1] has pointed out, the cheek spine in these asaphids is to be regarded rather as a character of immaturity, diminishing in size as the adult condition is approached, than as one of critical value for specific separation.

The presence of muscle scars in the pygidia of this species observed in material from Rysedorph hill, has already been mentioned. Isotelus maximus ranges from the Trenton into the Richmond beds; Isotelus gigas is reported from the Chazy of Canada. (Cement and groups 5, 7)

[1] Geol. Minn. Pal. 1897. v. 3, pt 2, p 701.

2 Subgenus GERASAPHES Clarke

Gerasaphes ulrichana Clarke. Geol. Minn. Pal. 1897. v. 3, pt 2, p. 710

In the reddish gray compact limestone a small pygidium of an asaphid was found, which possesses the broad and short form, broad, flat border, strong annulation of the axis and distinct pleural ribs with deep pleural grooves of the pygidium, referred by Dr Clarke, on account of its presenting characters of the earlier representatives of the Asaphus stock at the time of the decline of the race, together with the presence, in other parts, of strong corresponding gerontic characters, to a new genus, Gerasaphes, and described as the type species, G. ulrichana. Miller has claimed (in his 2d appendix to *American geology and paleontology* 1897, p. 788) that the same form was described before by Meek as Proetus spurlocki[1]; and at the same time it has been suggested that these fossils may represent the young of Asaphus megistus, to which Proëtus spurlocki was referred by Miller in the first edition of his *American geology and paleontology*. It does not seem, with the evidence thus far gathered, opportune to unite these species and the subgenus Gerasaphes with the common Trenton Isotelus, for it must be assumed that Hall as well as Meek and Clarke described their species with the knowledge of the characteristics of the young of Isotelus. Hall and Meek figure specimens of Isotelus side by side with this new form; Meek, even a young Isotelus on the same plate with his Proëtus spurlocki, and Clarke compares his form with the immature stages of the race. On the other hand, it might be urged that all these forms described as new refer to very small specimens, and have been found at different horizons, Proëtus spurlocki in the lower part of the Cincinnati group, G. ulrichana in the Utica beds, thus giving a form which should represent only a final stage of development a rather long range, and also that all have been found associated with Isotelus gigas-maximus (=megistus); facts which would suggest the specific

[1] Am. jour. sci. 1872. 3:426.

identity of these forms with Isotelus gigas. As long as the development and stages of Isotelus are not fully known, it seems eminently proper to denote the presence of these remains of immature character by the first specific name proposed for them, and by the subgeneric term which has been originated to include forms of the descending line of the Asaphidae, exactly corresponding with the generally recognized subgenera Ptychopyge and Niobe of Angelin in the ascending series of the Asaphidae. (Group 6)

ILLAENUS Dalman

Illaenus americanus Billings. Can. nat. and geol. 1859. 4:371

Cranidia and pygidia of this species are frequently found in the gray crystalline and the black compact limestone. They range in size from 1 mm in length to the normal size of adults. Most of them show the characteristic even convexity of the glabella of this species (an exception is made for several large cranidia from the pebbles with Tretaspis, in which the posterior half is nearly flat, and the anterior part consequently more abruptly bent downward) the sigmoidal curve of the dorsal furrows and the fine squamous striae. In the proportions of the cranidia there exist wider differences, as was supposed by Billings, and it almost seems as if there were two series of heads, one wide and short, such as Billings figured, and one relatively narrow and long, the younger heads specially showing frequently the latter proportions. It is quite probable that these differences are of a sexual nature. Young specimens have the dorsal furrow extending longer, in the smallest examples to fully the middle of the cranidium, whence a shallower depression extends in the direction of the last outward turn of the dorsal furrow to the frontal margin, a feature which is more emphasized in the subgenus Thaleops.

Another character more distinct in young stages is a median depression on the cast of the cranidium, with a central ridge, both extending from the occipital ring to the frontal border. The integument shows only a corresponding faint median depression.

In mature specimens this feature is not observable. It is, however, known in European forms and has been recognized by Pompecki in specimens of Illaenus comas (pl. 3, fig. 19) and I. linnarssoni?., The two lunate cicatrices in front of the sigmoidal curves mentioned by Dr Clarke[1] from casts from the Galena limestone at Wykoff, are distinctly noticeable on some of these casts. Illaenus americanus is restricted in Canada, New York, and western localities, to the Trenton and can therefore be considered a good index fossil of that formation. Dr White has however lately reported this species as occurring also in the Black river beds of the Rathbone creek section on the West Canada creek near Trenton Falls. (Groups 5, 7)

THALEOPS Conrad

Thaleops ovata Conrad. Acad. nat. sci. Phil. Proc. 1843. 1:332

Two pygidia from the gray crystalline limestone agree with the descriptions of this part of the carapace of Thaleops ovata given by Conrad and later authors. Thaleops ovata has thus far been found in the Mississippi and Ohio basins, as well as in Canada, only in beds corresponding to the New York Lowville limestone. (Group 7)

CYPHASPIS Burmeister

Cyphaspis matutina *sp. nov.*

Pl. 4, fig. 5, 6, 7

Two small cranidia belonging to the genus Cyphaspis were found in the black limestone. The glabella is short, roundish subquadrangular, moderately and uniformly convex, sloping equally to all sides; surrounded by deep dorsal furrows and an equally deep frontal furrow. Three pairs of glabellar furrows are discernible, the first two faint, short and oblique, the third semicircular, extending to the occipital furrow, and separating a pair of less convex lobes, which extend a little beyond the lateral margin of the first and second lobes; the broad border slopes steeply to a narrow rim, somewhat upturned at the margin. The two specimens differ considerably in size, the one

[1] Geol. Minn. Pal. 1897. v. 3, pt. 2, p. 715.

being twice as large as the other, but they are otherwise too closely alike to allow a specific separation. The glabella and rim are apparently completely smooth, but show under the glass fine transverse striae. Neck ring nearly flat, depressed, with a central tubercle; occipital furrow distinct, nearly straight. Sutures begin at the anterolateral angles of the margin, extend in the direction of the second glabellar lobe to near the glabella, and then curve backward. Only a few species of this genus are known from the Lower Siluric of America, viz:

C. girardeauensis Shumard,[1] which, though approaching this species in the outline of the glabella, differs distinctly by the much narrower frontal limb of the fixed cheeks, which in C. matutina is almost as wide as the glabella, while in C. girardeauensis the interspace between the glabella and the rim is not broader than the latter.

C.? brevimarginata Walcott, from the Pogonip of the Eureka district of Nevada, has an entirely different glabella, which is conic in shape, and the frontal limb consists only of a narrow rim in front of the glabella, and

C.? galenensis Clarke, from the Galena shales at Cannon Falls Minn., which, though possessing a similarly formed glabella, lacks the basal glabellar lobes.

The lower Siluric of Europe is also very poor in species of Cyphaspis. According to Frech a representative not yet specifically determined is reported from the Chasmops limestone of Sweden. Barrande describes a similar species as C. sola, from the *étage* D, at Koenigshof, which comes nearest to the species from Rysedorph hill, specially in the width of the frontal limb and the direction of the anterior part of the suture line, but the glabella is not so nearly square in front, and the basal lobes are a little more separated from the glabella. It approaches in this feature more the C. girardeauensis. Pompecki describes and figures a similar form as Cyphaspis parvula[2] from glacial boulders of the province of East Prussia, probably derived from the Phaseolus kalk. (Group 5)

[1] Geol. Mo. 1855. p. 197, pl. 8, fig. 11.

[2] Trilobiten-fauna der Ost- und Westpreussischen Diluvialgeschiebe, pl. 6, fig. 28.

Cyphaspis hudsonica *sp. nov.*

Pl. 4, fig. 8, 9

In this connection may be mentioned a cranidium found in the upper Utica shale of Green Island (*see* state museum, Bul. 42, p. 526) which, though somewhat defective, deserves notice on account of the rarity of this genus in these lower terranes, and the fact that no representative of the same has as yet been observed in the Utica shale.

The glabella is broadly subovate, with a subangular frontal lobe, truncate behind, flanked by deep dorsal furrows, moderately convex (apparently somewhat compressed as indicated by a longitudinal median fold); the basal lobes are distinctly set off; the full extent of the basal glabellar furrow is, however, not known; no other glabellar furrows are observable. The frontal limb is only little depressed below the surface of the glabella in front of the latter, and slopes but slightly toward the frontal rim, more rapidly toward the facial sutures; the frontal rim is thick, almost vertically upturned, forming part of a curve; from the intersection with the frontal rim the facial sutures turn obliquely toward the basal lobe, running then parallel to the dorsal furrow, and leaving a small strip at the side of the glabella.

Though this is all that is known of this species, it is sufficient for the generic determination of the form, and the demonstration of the presence of the genus within the Utica beds. This form closely approaches most Shumard's C. girardeauensis, and differs apparently only in the greater breadth of the frontal limb left between the facial sutures, which intersect the frontal rim farther back, and approach the glabella more rapidly in that western form. It is also similar to C. matutina in all parts except the narrower frontal limb; the rim in the Trenton form is only little upturned and rather flat, but here thick and sharply upturned. More extensive material may necessitate uniting both the Trenton and Utica forms under one specific name. With our present knowledge it would seem

more practical to emphasize the difference, and to recognize the form by a separate term.

Horizon and locality. Upper Utica shale, Green Island, near Albany N. Y.

BRONTEUS Goldfuss

Bronteus lunatus Billings. Geol. sur. Can. rep't progress. 1853-56. p. 338

Pl. 4, fig. 10, 11

A single cranidium from the black limestone, which proves to belong to the only species of Bronteus yet found in the North American Lower Siluric, viz Bronteus lunatus Billings. The character of the species, which is said by Billings to be not infrequent in the Trenton limestone of Ottawa, but which hitherto has not been represented in the state of New York, was fully elucidated by Billings, and its relations to the subdivisions of Bronteus commented on by Dr Clarke, who reports it from the Trenton limestone near Springvalley and Wykoff, Minn. Lately the species has also been reported from the Trenton of the far northwest (Birch island, Kinwow bay, Lake Winnipeg) by J. E. Whiteaves.[1]

The species is said to possess all the characteristic features of a typical Bronteus, but, as pointed out by Clarke, it possesses only six pygidial ribs, while by far the greater number of species of Bronteus possess seven, and it agrees in this regard with the two species known from the corresponding lower Siluric beds of Europe, viz B. laticauda Wahlenberg and B. hibernicus Portlock.

B. lunatus Billings is thus far only known from the Trenton limestone and according to Billings restricted to it.

Horizon and locality. Black compact limestone pebble with Tretaspis, Ampyx, etc. from the Rysedorph hill conglomerate. (Group 5)

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[1] Pal. foss. 1897. v. 3, pt 3, p. 235.

CYBELE Lovèn

Cybele *sp.*

Pl. 4, fig. 12

From a pebble of compact, black limestone the anterior part of a pygidium was obtained, which, though not furnishing enough data for the description of the species, is still interesting enough to elicit a few remarks.

The axis is long, conical; its annulations are, in the anterior parts, indicated only along the margin, in the middle part suppressed and the ornamentation furnished by two pairs of tubercles, while more posteriorly the annulations extend entirely across the axis. There are five pygidial pleurae which leave the axis under nearly right angles but gradually become deflected to a direction parallel with the axis. A few tubercles appear on these pleurae.

The character of the deflection of the pleurae leaves no doubt that this fragment belongs to the genus Cybele. Only one representative of this encrinurid genus has thus far become fully known from the North American Paleozoic rocks, viz, Cybele winchelli Clarke, from the Galena (?) limestone of Minnesota.[1] A pygidium has further been figured by Billings[2] as belonging to Encrinurus mirus, which indicates the presence of Cybele in that part of the Quebec group of Newfoundland that is homotaxial with the New York Black river or lower Trenton group. From Cybele winchelli our form differs markedly in not having the pleurae deflected abruptly and in the tuberculation and character of the annulations upon the axis. But it differs from the Newfoundland specimen apparently only in its slow tapering axis, and fuller material would probably prove the identity of the New York and Newfoundland forms.

In the Lower Siluric of Europe occur quite a number of species of Cybele, viz, 9 in Russia, 6 in Scandinavia, and 2 or 3 in England (according to Zittel). This relative frequency of Cybeles in Europe contrasted with their extreme rarity in the homotaxial American formations would already suggest the probable deriva-

[1] Geol. Minn. Pal. 1897. v. 3, pt 2, p. 742.

[2] Can. pal. foss. 1865. v. 1, p. 291, fig. 282.

tion of the eastern North American forms from European forms, a suggestion which is corroborated by the close relationship of the New York and Newfoundland forms with the common tuberculate Cybele verrucosa Dalm. of the Caradoc and Llandeilo of Great Britain. The specimen in the writer's hands differs in no essential features from the pygidia figured by McCoy[1] as Zethus atractopyge, sexcostatus and rugosus, which names are synonyms of Cybele verrucosa.

Horizon and locality. Gray limestone pebble of Rysedorph hill. (Group 7)

CALYMMENE Brongniart

Calymmene senaria Conrad. N. Y. geol. sur. 4th an. rep't Pal. 1841. p. 49

A large head, marked by its long shovel-shaped anterior expansion as belonging rather to this species than to C. callicephala Green[2] was found in the black limestone. This is the common Trenton form, while C. callicephala occurs in the Trenton as well as in the Lorraine beds. (Group 5)

CERAURUS Green

Ceraurus pleurexanthemus Green. Monograph tril. N. Am. 1832. p. 83

Cranidia and free cheeks are common in the pebbles of gray crystalline limestone and rare in those of compact black limestone. This form has a very considerable vertical range and wide geographic distribution; it ranges from the Lowville limestone to the Lorraine beds and has been found in Baffin Land (Schuchert) as well as in Manitoba (Whiteaves) and in the eastern and central parts of the United States. (Groups 5, 7)

SPHAEROCORYPHE Angelin

Sphaerocoryphe major *sp. nov.*

Cf. Sphaerocoryphe robustus Walcott. Cin. quar. jour. sci. 1875. 2:273

Pl. 4, fig. 13, 14

Two cranidia with spheric glabellar frontal lobes were found in the black limestone pebbles which are filled with specimens of

[1] Sedgwick and McCoy, Brit. Pal. foss 1855. pl. 1G, fig. 1–8.

[2] On the relation of these species see Geol. Minn. Pal. 1897 v. 3, pt 2, p.699.

Tretaspis. A comparison of this with typical specimens of S. robustus in the state museum, one of which is figured here, and with Walcott's careful description of this interesting species demonstrated the fact that there exists no tangible difference in the morphology of the cranidia, but that the Rysedorph hill specimens were four times as large as that species. As the cranidia of all the species of the genus are uniformly constructed, the failure to find differences between the two Trenton forms is of but little importance in the face of the great difference of size, and the latter must be regarded as forbidding an unqualified identification. Walcott obtained his species from the upper third of the Trenton limestone of Trenton falls. It has apparently not yet been found in any other locality, if two spheric anterior terminations mentioned by Whiteaves from the region of the Lake Winnipeg as Staurocephalus *sp. indet.* are not indicative of the occurrence of this or a congeneric species in the Trenton of the northwest; for, the glabellas of Staurocephalus and Sphaerocoryphe differ essentially only in the number of glabellar furrows behind the bulbous anterior lobe, Staurocephalus having three pairs and Sphaerocoryphe only two, and the bulbous frontal lobe alone does not permit an exact determination of the generic relation of a form.

The genus Staurocephalus is at present known in America only by the species S. murchisoni from the Niagaran of Arkansas and Illinois (*fide* Gilbert van Ingen). The genus Sphaerocoryphe is well represented in the lower Siluric of northern Europe, while in America only one other species has been made known by Billings from the Anticosti group.

DALMANITES (Emmerich) Barrande

Dalmanites achates Billings. Can. nat. 1860. 5:63

Specimens of Dalmanites achates represented by cranidia and pygidia were found in the gray crystalline limestone, the cranidia exhibiting the characteristic broad curve of the frontal margin, and the pygidia the narrow, elongate, tri-

angular outline with about 14 annulations on the axis, and about 10 ribs with pleural grooves. The species was originally described from the Trenton limestone of Ottawa. Dr Clarke figures a specimen from the Trenton limestone and reports it from the middle Trenton of Minnesota, and in a variety with extremely broad frontal lobe of the glabella from the Hudson river group at Cincinnati. As no mention of this form is made in other reports of Trenton faunas, it is either often overlooked by failing to be distinguished from Pterygometopus callicephalus or is of rare occurrence, as asserted by Billings. (Group 7)

PTERYGOMETOPUS Schmidt

Pterygometopus eboraceus Clarke. Geol. Minn. Pal. v. 3, pt 2, p. 728
Pl. 4, fig. 15

Two cranidia, obtained from a gray crystalline limestone boulder, were found to agree with the description and figures of the corresponding parts given by Dr Clarke of a new species, collected at Rawlins Mills in Saratoga county. The important features which demonstrate the identity of the forms from Rysedorph hill with that species, are the convexity of the median portion between the first and second lobes, the short incised character of the separating furrows at their inner extremities, and the confluence of the lobes along the dorsal furrows, as well as the presence of a conspicuous tubercle at the center of the occipital ring.

The occurrence of this form in the pebbles of the Rysedorph hill conglomerate seems to be of special interest, as the species has thus far been found only in the Trenton limestone at Rawlins Mills, hence in beds which outcrop only a relatively short distance to the north, and which may be contiguous with those from which these boulders were derived.

A new species more closely related to Pt. eboraceus than to any other species has lately been described from the Trenton of Silliman's Fossil Mount on Frobisher bay in Baffin Land. (Group 7)

Pterygometopus callicephalus Hall *sp.*

Phacops callicephalus Hall. Pal. N. Y. 1847. 1:247

Numerous cranidia and pygidia of this species were found in the gray crystalline and black compact limestone pebbles, and a few also in the reddish gray, hard limestone pebbles. P. callicephalus ranges from the Lowville limestone into the Trenton beds and occurs from Canada and New York to Minnesota and the Winnipeg region. (Groups 5, 6, 7)

LEPERDITIA Rouault

Leperditia fabulites Conrad *sp.*

Cytherina fabulites Conrad. Acad. nat. sci. Phil. Proc. 1843. 1:332

Pl. 5, fig. 19, 20

A small number of this robust ostracode type were found in the gray crystalline limestone boulders of Rysedorph hill, some of them of considerable size, as shown by the natural size figure of the largest specimen (pl. 5, fig. 19). The writer does not believe that much can be added to the exhaustive description given by Ulrich,[1] who had a large amount of material at command. A peculiar feature is shown by the largest specimen figured, which, probably, has some relation to the two series of small papillae observed by Ulrich on the inner side of the anterior and posterior thirds of the right valve. The specimen from Rysedorph hill, which is also a right valve, shows on the outside, in a position corresponding to the internal papillae, six radiating furrows which, beginning at the internal margin of the small, short, flat border, into which they enter, become shallower and narrower toward the margin. The flat rectangular interspaces are each marked by a very distinct flabellate group of striae (fig. 20).

Leperditia fabulites is a characteristic and common fossil of the Lowville limestone in New York about Lake Huron and other parts of Canada, Kentucky, Illinois, Tennessee, Wis-

[1] Geol. Minn. Pal. 1897. v. 3, pt 2, p. 624 f.

consin and Minnesota; it has also been found in the Black river beds of the Poland limekiln section by White[1] and in the Moshier quarry, near Newport, by Prosser and Cumings;[2] and in the Trenton of Canada and New York, where the last named investigators found it[3] in the upper third of the limestone section at Trenton Falls, and in the limestone of Tribeshill, and Pattersonville in the Mohawk valley. (Group 7)

Leperditia resplendens ***sp. nov.***

Pl. 5, fig. 21–27

Valves subrectangular, hinge line straight, cardinal angles drawn out into mucros, anterior and posterior ends subparallel, the anterior slightly truncate, ventral margin little curved, subparallel to the dorsal line, ventral angles uniformly rounded.

Surface forming an inclined plane, beginning near the ventral margin and sloping sometimes with a slight convexity or concavity to the hinge line, ventral slope abrupt, vertical, or even slightly overhanging. Surface when well preserved strongly glossy, in oblique light, however, exhibiting a very shallow pitting as of internal pores shining through the surface layer. Eye tubercles distinct in a shallow nuchal furrow. Muscle spot often externally indicated as a round shallow pit.

Most specimens show a very pretty, regular, pitting over the ventral part, separated by an irregularly jagged outline from the smooth glossy part, which lies higher than the pitted part of the shell. Other valves show only scattered fragments of the apparently smooth surface layer over the pitted part of the valve and there are other specimens where the entire surface is pitted. In those forms where the surface cuticle is somewhat less exfoliated, the position of the muscle spot is indicated by a more or less asteroidal fragment of the smooth layer preserved above the pitted parts.

A deep furrow passes from near the cardinal angles around the

[1] Trans. N. Y. acad. sci. 1896. 15:83.
[2] N. Y. state geol. 15th an. rep't. 1898. 1:631.
[3] N. Y. state geol. 15th an. rep't. 1898. 1:625.

ventral margin, and a narrow inward beveled margin is observable in other specimens.

Dimensions. Length .9 mm, hight .6 mm, thickness .1 mm; other specimens .11 x .7 x .1 mm; .11 x .8 x .1 mm.

Horizon and locality. Extremely common in the more fine-grained parts of the gray crystalline and of the compact reddish gray limestone pebbles, where it, in spite of its very minute size, belongs to the striking fossils by the pretty gloss on its deep black valves. (Groups 6, 7)

ISOCHILINA Jones

Isochilina armata Walcott *var.* **pygmaea** *var. nov.*

Leperditia (Isochilina) armata Walcott. N. Y. state mus. 35th an. rep't 1884. p. 213, pl. 17, fig. 10

Pl. 7, fig. 19–25

About 20 specimens of this crustacean have been found in the pebbles of compact reddish gray and black limestone and agree in all essential features with that described by Walcott from the Lowville and Black river limestone of Russia, Herkimer co. N. Y. The greatest difference between this species and the variety from Rysedorph hill is found in the relative size, Walcott's type measuring 8.5 mm, while the specimens from Rysedorph hill only range between .85 mm and 2.15 mm, the average size of the majority of the apparently mature specimens being 2 mm.

Both forms have in common the elongate carapace, straight hinge line, mucronate anterior and posterior cardinal angles. The large type is farther described as having the anterior extremity broadly rounded; ventral curve uniform, posterior extremity obliquely rounded to the ventral curve, a relation between the margins which also appears in some of the specimens figured, while in the great majority, as also in Walcott's specimens, both anterior and posterior margins are nearly equally rounded.

The most characteristic feature of this species, and the one which gave it its name, is a strong unciform spine, described as

projecting "obliquely outward, the apex extending beyond the ventral margin and curving towards the anterior extremity of the valve; the section of the spine at the base is elliptical, becoming sharply angular on the posterior side as it nears the apex." The shape and relation of this spine seems to be subject to some variation, as in the largest specimen found and figured (pl. 7, fig. 20) it is short and clawlike, while some younger ones possess a remarkably long and straight spine (pl. 7, fig. 24). This is always situated in the posterior half and directed posteriorly, the anterior half being marked by its lesser convexity and the often very distinct eye tubercle. If the tubercle shown in the figure of Walcott's type specimen also represents the eye tubercle, the spine is directed backward in that form also. The surface of the specimens from Rysedorph hill is smooth and shining; the muscle spot has not been observed.

A feature not mentioned in the description of the type, but indicated in the drawing and of great prominence in the writer's material, is a depression, extending medially from the middle of the cardinal line to the ventral margin. In internal casts of this thick-shelled ostracod it appears as a very deep furrow slightly curved ventrally. A shorter impression corresponding to the nuchal furrow is sometimes observed on the anterior half; it does not, however, contain the eye tubercle, which lies farther forward.

On account of the absence of any observable overlap, the leperditoid form, the shallow median depression and the distinctness of the eye tubercle and muscle spot, this form is better retained under the genus Isochilina, and is probably not related to other genera with a similar median depression such as Leperditella and Primitiella.

Horizon and locality. Black and reddish gray compact limestones of the Rysedorph hill conglomerate. (Groups 5, 6)

APARCHITES Jones

Aparchites minutissimus Hall *var.* **robustus** *var. nov.*

Leperditia (Isochilina) minutissima Hall. Descrip. sp. foss. Hud. riv. gr. 1871. p. 7

Pl. 7, fig. 6–11

In the black compact limestone associated with Remopleurides linguatus several specimens of Aparchites were found, which not agreeing fully with the description of the species above cited are considered as representing a variety of it.

Diagnosis. Carapace elongate oval, rather large for this genus, cardinal margin slightly concave, cardinal angles rounded, anterior margin narrowly rounded, ventral margin obtuse posteriorly, posterior margin broadly and evenly rounded, posterodorsal part truncate. Valve quite strongly and very evenly convex, highest part near the center, or a little posteriorly and ventrally of the center. Ventral edge narrowly and slightly beveled. No sulcus, eye tubercles, or muscle impressions observable. Surface smooth.

Dimensions. Largest specimen (fig. 9): length, 2.4 mm; hight, 1.4 mm; thickness .7 mm.

Horizon and locality. Black compact limestone pebbles of the Rysedorph hill conglomerate. (Group 5)

Observations. Two specimens have been figured, which present considerable difference in relative hight and length, the larger, which is about normal, being relatively longer than the smaller and relatively higher specimen. This type does not present any marked differences from Aparchites minutissimus, specially from the Trenton variety of this species, described by Ulrich, except in the great difference in size, this form being more than twice as large as the other.

SCHMIDTELLA Ulrich

Schmidtella crassimarginata Ulrich *var.* **ventrilabiata** *var. nov.*

Schmidtella crassimarginata Ulrich. Am. geol. 1892. 10:269

Pl. 7, fig. 12–18

Under this varietal designation a form is characterized, which is extremely common in the reddish gray, compact, ostracode limestone of Rysedorph hill.

Diagnosis. Carapace broadly suboval, almost equilateral; hinge line nearly straight, shorter than the length of the valve; cardinal angles obtuse, anterior and posterior margins strongly rounded, the posterior a little more than the anterior one; ventral outline of body of valve uniformly curved. Body of valve very strongly convex, highest dorsally of the center, back of valve projecting above the hinge line, causing the dorsal outline to appear more or less arcuate, and producing an incurving triangular cardinal area. A depressed convex to flat border begins at the cardinal angles and encircles the valve, rapidly widening in the ventral region, and mostly assuming the form of a tongue-shaped or lip-shaped lappet. Surface smooth and shining.

Dimensions. Length of body of valve of one specimen .7 mm, hight of same .45 mm; thickness .3 mm; width of ventral border .2 mm; length and hight of body of valve of another .9 mm and .6 mm and width of border .2 mm.

Horizon and locality. Reddish gray compact, ostracode limestone pebbles of the Rysedorph hill conglomerate. (Group 6)

Observations. This form agrees in all principal features with Schmidtella crassimarginata Ulrich, from the Stones river (Lowville limestone) of Mineralpoint Wis., and Dixon Ill. It differs only in the stronger development, specially in the ventral region, of the marginal border, a difference which can not be considered to indicate more than a regional variety within the confines of the species.

EURYCHILINA Ulrich

Eurychilina reticulata Ulrich. Contrib. Can. micro-pal. 1889. pt 2, p. 52

Pl. 5, fig. 3

In the reddish gray limestone several specimens of a very pretty ostracode were found, which, by their reticulate surface, shape and extent of the sulcus and the structure of the marginal area, prove their identity with Ulrich's Eurychilina reticulata. In view of the equality of their important characters, no value can be attributed to certain small differences, as the smaller size of the pits. Eurychilina reticulata has been found heretofore only in the Lowville and Black river limestones of the west. (Group 6)

Eurychilina bulbifera *sp. nov.*

Pl. 5, fig. 14–17

Diagnosis. Carapace nearly semicircular, rather high, with straight cardinal margin, strongly rounded anterior and posterior margins, and less curved ventral margin. Sulcus about one third of the length of the valve from the posterior end, deep, extending one half the width of the convex part of the carapace. Posterior part distinctly bulbous, higher than the rest of the shell. Anterior and middle part strongly convex, highest ventrally of center. Broad marginal area, with widely separate but very high radial folds, exteriorly concave, abruptly upturned at the margin, where a vertical outer closing wall is observable. Surface finely granulose, with the exception of the marginal area, but the vertical closing wall is distinctly granulose.

Dimensions. Length of larger specimen 1.4 mm, hight .9 mm, thickness .4 mm.

Horizon and locality. In the compact reddish gray and gray crystalline limestone pebbles of the Rysedorph hill conglomerate. (Groups 6 and 7)

Observations. This form may be easily distinguished from other members of the genus by its short, convex form, large, strongly

bulbous posterior part, strong sulcus and granulose surface. Its posterior bulb suggests species of Ctenobolbina, but as also other Eurychilinas have a small node just posteriorly of the sulcus, it is evident that this bulb only represents an extravagant development of such node. The degree of its convexity and its granulose surface are features in which it is comparable to E. granosa, and E. subaequalis Ulrich, but these latter do not possess the upturned marginal border, nor the strong development of the posterior node.

Eurychilina (?) solida *sp. nov.*

Pl. 5, fig. 18

A single specimen of a granulose Eurychilina found in the compact ostracode limestone of Rysedorph hill, agrees in most characters with the preceding species but differs in others. These are the perfect separation of the sulcus from the cardinal line, the sulcus forming here a small deep crescent-shaped pit near the middle of the valve; the remainder of the carapace, except the marginal area, is strongly and very uniformly convex; and the marginal area more strongly concave, and rising much higher than in E. bulbifera. A break just behind the sulcus seems to indicate the presence of a node. The exterior and interior closing walls of the marginal area have not been observed, and it is, therefore, not certain whether this form is really a Eurychilina, or possesses only a simple border or "frill."

Dimensions. Length 1.2 mm; hight .9 mm; thickness .3 mm.

Horizon and locality. Compact gray limestone pebbles of the Rysedorph hill conglomerate. (Group 6)

Eurychilina subradiata Ulrich *var.* **rensselaerica** *var. nov.*

Eurychilina subradiata Ulrich. Geol. Minn. Pal. 1897. v. 3, pt 2, p. 663

Pl. 5, fig. 4–7, 13

Diagnosis. Carapace rather large, elongate, semi-elliptic to subtrapezoidal, cardinal line longer than any other part of the shell, straight, cardinal angles short; anterior and posterior

margins nearly equally converging toward the ventral margin, which is subparallel to the cardinal line. Depressed convex, the highest part consisting of an obtuse ridgelike prominence, running across the shell longitudinally and ventrally of the center; from the ridge the valve slopes evenly or with slight concavity toward the thickened cardinal edge. Sulcus rather broad, situated mostly somewhat posteriorly of the median line, and beginning a little ventrally of the cardinal line. No distinct node or bulb situated behind the sulcus. Marginal area consisting of a high angular ridge, which encircles the entire lateral and ventral margins of the valve, and which varies somewhat in breadth, but always becomes narrower along the ventral margin, where it abruptly turns downward. Outside of this lies still a narrow, flat, radially striated border, which, however, is mostly broken off. Surface in some specimens very coarsely pitted, in others very faintly so, in most, however, perfectly smooth. Shell very thin, specially the marginal area.

Dimensions. Length 2.1 mm; hight 1 mm; thickness .4 mm.

Horizon and locality. Common in the gray crystalline and compact limestone pebbles of the Rysedorph hill conglomerate. (Groups 6, 7)

Observations. This form has all the essential features of Eurychilina subradiata Ulrich; it differs only in the absence of the distinct node and the more acute cardinal angles, differences which are of not more than varietal importance, such as the same species is very likely to develop in widely separated regions. Eurychilina subradiata has thus far been found in Illinois, Tennessee, Wisconsin, and Minnesota, where it is restricted to the Lowville limestone.

Eurychilina dianthus *sp. nov.*

Pl. 5, fig. 1, 2, 8, 9

Diagnosis. Valve very thick, suboval, equilateral; cardinal line straight, cardinal angles obtusely rounded, anterior and posterior margins nearly equally and strongly rounded;

ventral margin more gently rounded. Body of valve moderately to strongly convex, highest in the central region, from which it slopes equally to all sides. The largest of the figured specimens, which is slightly exfoliated, shows an apical muscle impression; another an elongate prominence, situated nearer to the cardinal line, evidently the filling of a muscle impression; while a third specimen (pl. 5, fig. 2) which has the crust preserved, shows an elongate kidney-shaped apical impression, which is evidently the last trace of the sulcus. Marginal area not concave and curved outward as in the other species, but more or less convex and curving inward, becoming wider toward the ventral region, and provided with strong radiating ribs, which in some specimens are partly composed of granules. Surface very faintly granulose.

Dimensions. Length 2.1 mm; hight 1.6 mm; thickness .6 mm.

Horizon and locality. Gray crystalline limestone pebbles of Rysedorph hill conglomerate. (Group 7)

Observations. This interesting form can be compared only with Eurychilina aequalis, from the Chazy and Lowville limestone (Stones river group) of Kentucky,[1] from which it seems to differ only in not possessing a distinct sulcus, and in having the marginal area strongly ribbed.

Eurychilina obliqua *sp. nov.*

Pl. 5, fig. 10–12

There have been found in the gray limestone several large specimens of Eurychilina which are nearly related to E. dianthus, but differ uniformly in certain important features. These are the more elongate form of the semi-elliptic valve, the greater convexity of the body of the valve, and the situation of the apex of the convexity in the posterior half, whence the valve evenly slopes anteriorly, the entire absence of any trace of an apical sulcate impression, and the considerably greater width of the marginal convex area, which soon reaches its full

[1] Cin. soc. nat. hist. Jour. 1890–91. 13:129.

width in front, while posteriorly it narrows considerably. The ribs of the marginal area are finer than in the preceding species. On account of the posterior convexity of the body of the valve and the inequilateral development of the marginal area, the entire valve has a strongly symmetric appearance.

Dimensions. Length 2.4 mm; hight 1.7 mm; thickness .9 mm.

Horizon and locality. Gray limestone of Rysedorph hill. (Group 7)

There is no species known to the writer which is suggested by this form. If the development of the sulcus is taken into consideration, it seems to stand at the end of a series which begins with such forms as E. bulbifera, where the sulcus is deep and long and begins at the cardinal line. It then begins to wander ventrally, till it appears as a crescent-shaped pit only, separate from the cardinal line as in E. granosa and in E. solida; it farther becomes faint, and may eventually disappear entirely as in E. obliqua. At the same time the forms with faintly developed sulcus have more rotund valves, and mostly a convex instead of a concave marginal area; they form, hence, apparently a natural group of species, which eventually may be advantageously comprised under a subgeneric term.

PRIMITIA Jones & Holl

Primitia mundula Miller *var.* jonesi *var. nov.*

Primitia mundula S. A. Miller. Cin. quar. jour. sci. 2:350, and Ulrich, Cin. soc. nat. hist. Jour. 1890-91. 13:132

Pl. 7, fig. 2–5

The conglomerate affords very minute representatives of the genus Primitia, which have been found to belong all to one type that probably stands in varietal relation to Primitia mundula S. A. Miller.

Diagnosis. Carapace very minute, strongly convex, subquadrate-ovate, dorsal margin long, straight; anterior cardinal angle obtusely rounded, posterior a little less obtuse; anterior mar-

gin strongly rounded, ventral margin more gently curved, posterior margin less curved, truncated above; sulcus in about the middle of the valve, deep ventrally, not reaching to the middle of the valve, curving slightly backward in the lower part; dorsal parts on both sides of the sulcus somewhat bulbous, the anterior part more distinctly so. Well preserved specimens show a flat border sloping steeply outward. Internal casts (fig. 5) possess a prominent tubercle at the inner end of the sulcus, evidently indicative of a deep muscle impression. Surface very finely granulose, the granules arranged in longitudinal rows, so that with a weaker glass the surface appears to be marked by longitudinal, anastomosing striae.

Dimensions. Length .7 mm; hight .5 mm; thickness .2 mm.

Horizon and locality. In the pebbles of gray crystalline limestone and of black compact limestone, Rysedorph hill. (Groups 5, 7)

Observations. These minute fossils show considerable similarity to P. mundula S. A. Miller, from the upper half of the Cincinnati group. They differ in being a little larger, in having the tumid dorsal parts more strongly developed, and specially in having a finely granulose surface. In consideration of the variability of P. mundula, shown by Jones and Ulrich, it is very probable that this form is only an earlier variety of the Cincinnati type. Jones's P. logani, from the Canadian Chazy (?) and Trenton, has the front moiety mostly narrower than the hinder part and is smooth and punctate, while his P. mundula var. effossa from the dark and fine grained limestone from the south of Montcalm market, Quebec city, is a form quite similar to ours, but differing still in being longer, having the sulcus developed in the center into a large pit and in being smooth. It occurs in beds which Lapworth and Ami have shown to contain the fauna of the Normans kill beds, in which the Rysedorph hill conglomerate is embedded, so that both these varieties of P. mundula are of older Trenton age.

BOLLIA Jones & Holl

Bollia cornucopiae *sp. nov.*

Pl. 6, fig. 1, 2

A single, odd-looking valve was found in the gray crystalline limestone pebbles from Rysedorph hill, which is referable to the genus Bollia Jones and Holl in a general way, but not to any of the species described as yet as constituting that genus.

Diagnosis. Valve subrectangular, cardinal line as long as the greatest length of the specimen, straight, cardinal angles nearly rectangular, anterior and posterior margins subparallel in the dorsal parts, curving inward ventrally, ventral margin subparallel to the cardinal line, shorter than the latter by one third. Body of valve flat, bearing a wide, u-shaped (horseshoe-shaped ridge of authors) which anteriorly widens into a broad, evenly depressed convex plate with an upturned border along the cardinal line; in the center of the valve it narrows abruptly into a semitubular ridge, which, slightly narrowing, completes the u-curve, curving inward at the cardinal line and ending with a small knob. Separated by a narrow furrow from this ridge and parallel with the lateral and ventral margins, runs the high marginal, obtusely angular ridge, which is highest along the lateral margins, and sinks rather abruptly at the antero and posteroventral angles almost to the level of the body of the valve. Its outer wall slopes very steeply. All parts of the apparently very thick-shelled valve are smooth.

Dimensions. Length 1.4 mm; hight 1.2 mm; thickness .7 mm.

Horizon and locality. One specimen found in a gray crystalline limestone pebble. (Group 7)

Observations. This valve has in general outline and the character of the marginal ridge some resemblance to the more common form referred to Eurychilina subaequalis in this paper. The central part, the flat body and u-shaped central ridge, however, are entirely different from the evenly convex body of that Eurychilina.

The flat body of the valve, the u-shaped ridge and the marginal ridge are all characteristic features of the genus Bollia, but, while one or both ends of the loop-shaped ridge may be bulbous in that genus, no species known to the writer presents such a great difference in the development of the two ends of this ridge, nor is the marginal ridge usually situated so closely to the margin as it is in this species.

MACRONOTELLA Ulrich

Macronotella ulrichi *sp. nov.*

Pl. 6, fig. 6–16

In the gray crystalline limestone pebbles of the conglomerate at Rysedorph hill and the Moordener kill (pl. 7, fig. 1) occur representatives of the genus Macronotella known only by one species from the Lowville limestone of the west. This genus is characterized by Ulrich as follows: "Carapace convex, semicircular or semiovate, with a long nearly straight hinge; valves equal, full centro-dorsally, without ridges or a sulcus, but exhibiting a smooth subcentral spot where the ornament is omitted; surface, in the only species known, coarsely punctate." The affinities of the genus are thought to be with Kirkbya. In the conglomerate beds two species have been found, which are distinctly allied to Macronotella scofieldi, the type of the genus.

Diagnosis. Valves three fourths circular to subovate; dorsal outline rarely straight, mostly prominent in the central part, specially in older specimens; cardinal angles obtusely rounded to shortly truncate; posterior margin with a little longer truncation, lateral and ventral margins forming approximately a continuous circular line, in larger specimens the anterior and posterior margins more strongly rounded, and the ventral margin less curved; free edges in most specimens with a broad depressed border and beveled edge. Surface strongly convex, culminating in the dorsocentral region; in some specimens almost smooth, with only faint, widely and irregularly distributed circular impressions; others

with very large deep pits; on the apex always a flat, smooth circular area. Valve projecting slightly above the straight cardinal line, and forming a broad, low, triangular, reentrant cardinal area.

Dimensions. Length 2.7 mm; hight 2.1 mm; thickness .7 mm.

Horizon and locality. In the gray crystalline pebbles of the conglomerate on Rysedorph hill and at the Moordener kill. (Group 7)

Observations. This pretty species agrees with the type of the genus Macronotella in its convex valves, culmination in the dorso-central region, apical smooth spot, border and coarse punctation; it differs in being relatively much shorter and having a shorter cardinal line; it also has obscure or truncate cardinal angles. It appears that the definition of the genus should be so modified for the reception of this and the next species, as to embrace forms of not only long but also of relatively short hinge line.

This form shows a slight similarity to a round, punctate species with beveled border and dorso-central apex, from Scandinavian upper Siluric beds, described by Jones as Aparchites decoratus.[1] The Swedish form does not apparently possess the apical smooth spot and has a very short cardinal line; its reception into the genus Macronotella would therefore be not advisable.

Another species which may be mentioned in this connection, is Isochilina amii Jones,[2] from the Trenton limestone of Loretto, province of Quebec. This species is described by Prof. Jones as follows: "A small black valve, ovate oblong; dorsal border long and straight; anterior end evenly and posterior one elliptically rounded, ventral edge nearly curved and obscurely crenulated. Surface marked with small scattered pits; greatest convexity at the hinder moiety." It is added: "This seems to differ from all known forms. It has the Leperditian shape of Isochilina, although no sulcus nor tubercle is visible." There

[1] An. and mag. nat. hist. 1889. p. 272.

[2] Contrib. Can. micro.-pal. 1891. pt 3, p. 68, pl. 10, fig. 14.

exists a great similarity between the habitus of this and M. u l r i c h i, which finds its expression in the slightly convex dorsal line, well rounded anterior and posterior sides, scattered pits on the surface border, and the obscurely crenulated margin, which is also indicated in some of the species from Rysedorph hill by a faint radiation and radial arrangement of shallow impressions on the border. On the other hand, the Quebec form is relatively longer, has its greatest convexity posteriorly instead of centrally, and lacks the central smooth space. Prof. Jones had apparently only a single valve for description, and the possibility is therefore not excluded, that more extensive material would have presented features more closely agreeing with M. u l r i c h i.

Macronotella fragaria *sp. nov.*

Pl. 6, fig. 3–5

Another valve of Macronotella was found in the same limestone, possessing different characters from the foregoing.

Diagnosis. Carapace elongate, semiovate; cardinal margin nearly straight, anterior and posterior cardinal angles very obtusely rounded; anterior and posterior margins boldly rounded, ventral margin less curved. Surface strongly convex, culminating a little ventrally and posteriorly (?) of the center, very coarsely punctate; in the center is a circular, slightly projecting, smooth, flat plate, from which a tapering ridge extends to near the cardinal line. No border observable.

Dimensions. Length, 1.7 mm; hight, 1.5 mm; thickness, .6 mm.

Horizon and locality. In the gray crystalline limestone pebbles of the Rysedorph hill conglomerate. (Group 7)

Observations. This form differs markedly from both the other species by its strongly rounded cardinal angles, the culmination of the valve ventrally and posteriorly from the center, the absence of the border and the presence of the tapering ridge. The absence of the dorso-central inflation and of the border removes this form so much from the typical expression of the genus that the propriety of referring thereto may be ques-

tioned. On the other hand, the general outline, coarse pitting, and the central smooth spot are indications of its undoubted close relationship to Macronotella. A very similar form has been described by Dr Gürich[1] as Primitia ornatissima, from the lowest middle Devonic of Dabrowa. This later species possesses also a regularly pitted surface, a subcentral smooth spot and a smooth furrow, extending from the central spot dorsally; it is not so regularly oval, has its longest diameter nearer to the cardinal line and is more lenticular in profile than M. fragaria. Dr Gürich compares his species with Primitia ornata Jones, from the Wenlock beds[2] a form which also bears comparison with ours, but differs in having angular cardinal angles and a coarsely reticulated surface.

As the smooth median ridge of Macronotella fragaria rests also on a smooth, very faint impression, the relationship also of this species to Primitia is quite apparent. It seems that M. fragaria occupies an intermediate position between those genera, differing in some features from the typical expression of both of them.

BYTHOCYPRIS Brady

Bythocypris cylindrica Hall *sp.*

Leperditia (Isochilina) cylindrica Hall. N. Y. state cab. nat. hist. 24th an. rep't. 1872. p. 231

Pl. 7, fig. 26–28

Bythocypris cylindrica is a form of extremely frequent occurrence in the reddish gray compact limestone, of common occurrence in the gray, more crystalline limestone, and rarely found in the black compact limestone pebbles. It was described by Hall as occurring in the Hudson river group at Cincinnati, and is reported by Ulrich from the Trenton and Utica beds of the Cincinnati region and from the Lower Trenton (Clitambonites bed) of Cannon Falls Minn. The New York form

[1] Das Palaeozoicum im polnischen Mittelgebirge. Verh. der kaiserl. Russisch. mineral. Gesellsch. zu St Petersburg. 1896. 2d ser. 32:383.

[2] An. and mag. nat. hist. 5th ser. 1886. 17:411.

does not show any difference from the Cincinnati type, nor any approach to the other, partly larger Trenton species, described by Ulrich. One specimen has been figured to show the remarkable tumidity of the central ventral third, which may be caused by a state of pregnancy, such as is frequently indicated in valves of Beyrichias. (Groups 5, 6, 7)

LEPIDOCOLEUS Faber

Lepidocoleus jamesi Hall & Whitfield *sp.*

Plumulites jamesi Hall & Whitfield. Ohio geol. sur. Pal. 1875. v. 2, pt 2, p. 106

Pl. 4, fig. 16–19

The black limestone of the Rysedorph hill conglomerate furnished two plates with crustacean structure, which, on comparison, proved identical with a specimen collected in the Rafinesquina deltoidea bed of the upper Trenton limestone of Trenton Falls. The latter has been figured by the writer in another paper, for comparison with the figures of specimens of Lepidocoleus jamesi, found to occur profusely in the lower Utica beds of Mechanicsville, and occasionally in the upper Utica beds on Green Island. Hall and Whitfield remark that they detected fragments apparently identical with their Plumulites jamesi on surfaces of Trenton limestone from Trenton Falls, and the writer in a former paper concurred with this identification, and is as yet not prepared to separate the Trenton and the later forms, though it seems that the Trenton specimens have more closely arranged transverse striations. A critical comparison of the Trenton and Utica material is however greatly hindered by the very different preservation of the plates in the shale, where they are nearly completely flattened and reduced to a mere film, and in the limestone, where they retain all details of profile and surface sculpture. The latter fact makes the specimens from Rysedorph hill specially worthy of notice. This surface sculpture consists of a very delicate but distinct cross striation of the interspaces between the coarser transverse striations, consisting of two systems of

fine striae, intersecting at nearly right angles. The cross striations appear in one specimen on the transverse striations as minute nodes. The presence of this extremely pretty and regular surface ornamentation is not a feature distinguishing it from the Utica form, as the latter, on reinvestigation also shows traces of it.

The species was originally founded on such isolated plates as occur in the beds around Albany. Later, an entire specimen was found, and, as it proved to consist only of two rows of plates, a new genus Lepidocoleus was founded for it.[1] Two more species of the same genus, one from the Rochester shales, and one from the Helderbergian beds were subsequently described by Dr Clarke[2], the characters of the genus still more fully elucidated and, specially, the highly simple, unmodified form of this group of barnacles pointed out. In recognition of the important differences between Lepidoleus and the Turrilepadidae, Clarke has placed the genus in a distinct family, the Lepidocoleidae.

Associated with the broadly triangular plates with sigmoidal base which compose by far the majority of all plates observed, occur also more narrowly leaf-shaped plates with somewhat drawn out apex and simply rounded base. Medially they are marked by a narrow carina, extending from the apex to about the middle of the base. As they are associated with the others, possessing the same size and surface sculpture, they are evidently parts of the same exoskeleton. One of these plates from the Trenton shales at Port Schuyler near Albany has been figured by the writer in museum bulletin 42 on the Hudson river shales of the vicinity of Albany (pl. 2, fig. 11). Faber's specimen shows only two rows of equal plates, which are none of them carinate, and the distal, caudal extremity of the specimen is missing. This part is retained in the specimen described by Clarke from the Rochester shale; the terminal plate of the latter is described as being grooved on its narrow back. It is, therefore,

[1] Cin. soc. nat. hist. Jour. 1886. 9:16.

[2] Am. geologist. 1896. 17:137.

probable, that the long, leaf-shaped plate figured by the writer represents this plate of the exoskeleton of Lepidocoleus jamesi, and that the apparent carina is the reverse side of that groove. Several specimens of this type of plate structure have been observed by the writer.

Dr Woodward has described[1] a species of Turrilepas, obtained by Dr Ami in the lower Utica beds of Ottawa, as Turrilepas canadensis. This species is quite certainly not identical with the one represented by the Trenton and Utica specimens of the vicinity of Albany, referred to Lepidocoleus jamesi, for its plates are about three times as large as those of the latter, and differ materially in shape; the carina also lies not medially but close to the longer side. (Group 5)

ANALYSIS OF THE FAUNA OF THE CONGLOMERATE

Fossils contained in the various kinds of pebbles

c=common; cc=very common; r=rare; rr=very rare

GROUP		
1	Gray limestone	
	Hyolithellus micans *Billings*	
2	Gray and reddish sandstone	
	None	
3	Black crystalline limestone (Chazy limestone)	
	Bolboporites americanus *Billings*	
	Palaeocystites tenuiradiatus *Hall* sp.	
4	Lowville limestone	
	Tetradium cellulosum *Hall* sp.	
5	Black compact limestone	
	Streptelasma corniculum *Hall*	c
	Diplograptus foliaceus *Murch.* sp.	r
	Climacograptus scharenbergi *Lapworth*	r
	Stomatopora inflata *Hall* sp.	c
	Stictopora *cf.* elegantula *Hall*	r
	Callopora multitabulata *Ulrich*	cc
	Siphonotreta minnesotensis *Hall & Clarke*	rr
	Crania trentonensis *Hall*	r
	Rafinesquina alternata *Emmons* sp.	c
	Leptaena rhomboidalis *Wilckens*	c
	Plectambonites sericeus *Sowerby* sp.	c
	P. pisum *sp. nov.*	cc

[1] Geol. mag. 3d ser. 1889. 26:274.

5	Black compact limestone (*continued*)	
	Christiania trentonensis *sp. nov.*	c
	Orthis tricenaria *Hall*	c
	Platystrophia biforata *Schlotheim* sp.	c
	Dalmanella testudinaria *Dalman* sp.	c
	Whitella ventricosa *Hall* sp.	rr
	Ctenodonta *sp. indet.*	rr
	C. *cf.* astartaeformis *Salter*	r
	Protowarthia cancellata *Hall* sp.	r
	Conradella compressa *Conrad* sp.	r
	Carinaropsis carinata *Hall*	r
	Lophospira bicincta *Hall* sp.	r
	Liospira americana *Billings* sp.	rr
	Eccyliopterus spiralis *sp. nov.*	rr
	Holopea paludiniformis *Hall*	rr
	Conularia *cf.* trentonensis *Hall*	rr
	Zitteloceras hallianum *d'Orbigny* sp.	rr
	Tretaspis reticulata *sp. nov.*	cc
	T. diademata *sp. nov.*	rr
	Ampyx (Lonchodomas) hastatus *sp. nov.*	cc
	Remopleurides linguatus *sp. nov.*	cc
	Isotelus maximus *Locke*	c
	Illaenus americanus *Billings*	c
	Cyphaspis matutina *sp. nov.*	r
	Bronteus lunatus *Billings*	rr
	Calymmene senaria *Conrad*	rr
	Pterygometopus callicephalus *Hall* sp.	c
	Ceraurus pleurexanthemus *Green* sp.	c
	Cybele *sp.*	rr
	Sphaerocoryphe major *sp. nov.*	r
	Isochilina armata *Walcott, var.* pygmaea *var. nov.*	r
	Primitia mundula *Miller, var.* jonesi *var. nov.*	r
	Aparchites minutissimus *Hall sp., var.* robustus *var. nov.*	c
	Bythocypris cylindrica *Hall* sp.	r
6	Reddish gray compact limestone	
	Rafinesquina alternata *Conrad* sp.	r
	Dalmanella testudinaria *Dalman* sp.	r
	Triplecia nucleus *Hall*	r
	Protozyga exigua *Hall*	c
	Carinaropsis carinata *Hall*	r
	Gerasaphes ulrichana *Clarke* sp.	rr
	Ampyx hastatus *sp. nov.*	r
	Remopleurides linguatus *sp. nov.*	r
	R. tumidulus *sp. nov.*	rr
	Pterygometopus callicephalus *Green* sp.	r
	Læperditia resplendens *sp. nov.*	c

6	Reddish gray compact limestone (*continued*)	
	Isochilina armata *Walcott, var.* pygmaea *var. nov.*	r
	Schmidtella crassimarginata *Ulrich, var.* ventrilabiata *var. nov.*	cc
	Eurychilina reticulata *Ulrich*	c
	E. bulbifera *sp. nov.*	r
	E. (?) solida *sp. nov.*	rr
	E. subradiata *Ulrich, var.* rensselaerica *var. nov.*	c
	Bythocypris cylindrica *Hall* sp.	cc
7	Gray crystalline limestone	
	Prasopora simulatrix *Ulrich, var.* orientalis *Ulrich*	r
	Rafinesquina alternata *Conrad* sp.	cc
	R. deltoidea *Conrad* sp.	r
	Leptaena rhomboidalis *Wilckens*	r
	Plectambonites sericeus *Sowerby sp., var.* asper *James*	cc
	P. pisum *sp. nov.*	r
	Triplecia nucleus *Hall*	c
	Orthis tricenaria *Conrad*	c
	Plectorthis plicatella *Hall*	c
	Dalmanella testudinaria *Dalman* sp.	c
	D. subaequata *Conrad, var.* pervetus *Conrad*	c
	Dinorthis pectinella *Emmons* sp.	r
	Parastrophia hemiplicata *Hall*	r
	Protozyga exigua *Hall*	c
	Zygospira recurvirostris *Hall*	c
	Modiolopsis *cf.* aviculoides *Hall*	r
	Conradella compressa *Conrad*	r
	Carinaropsis carinata *Hall*	c
	Lophospira bicincta *Hall* sp.	c
	L. perangulata *Hall* sp.	c
	Liospira subtilistriata *Hall* sp.	cc
	Clathrospira subconica *Hall*	c
	Trochonema umbilicatum *Hall* sp.	c
	Cyrtospira attenuata *sp. nov.*	rr
	Hyolithus rhine *sp. nov.*	rr
	Cyrtoceras subannulatum *Hall*	rr
	Spyroceras bilineatum *Hall* sp. ? (teste *Emmons*)	
	S. *cf.* anellus *Conrad* sp.	r
	Remopleurides linguatus *sp. nov.*	rr
	Isotelus maximus *Locke*	cc
	Illaenus americanus *Billings*	c
	Thaleops ovata *Conrad*	r
	Pterygometopus eboraceus *Clarke*	r
	P. callicephalus *Hall* sp.	c
	Dalmanites achates *Billings*	c
	Ceraurus pleurexanthemus *Green*	c

7 Gray crystalline limestone (*continued*)

Leperditia fabulites *Conrad*	c
L. resplendens *sp. nov.*	cc
Eurychilina bulbifera *sp. nov.*	r
E. obliqua *sp. nov.*	rr
E. subradiata *Ulrich, var.* rensselaerica *var. nov.*	c
E. dianthus *sp. nov.*	c
Primitia mundula *Miller, var.* jonesi *var. nov.*	r
Bollia cornucopiae *sp. nov.*	rr
Macronotella ulrichi *sp. nov.*	c
M. fragaria *sp. nov.*	rr
Bythocypris cylindrica *Hall* sp.	c

Tabulation of the faunas

The following tabulation of the organisms of the last three groups of pebbles is given to show the relative frequency of occurrence, and their vertical range in other regions.

Frequency and vertical range of species

B=Black river group; Ch=Chazy; D=Dicellograptus zone (Normans kill shale, Lower Dicellograptus zone); L=Lorraine beds; Lo=Lowville limestone (Birdseye limestone, Stones river group); R=Richmond beds; T=Trenton limestone; U=Utica beds.

	Gray limestone	Reddish gray limestone	Black limestone	N. Y.	Canada	West	Other regions
Streptelasma corniculum *Hall*	.....	.....	c	T	T	T	T of Baffin Land
Diplograptus foliaceus *Murchison* sp.	.....	.....	r	T-L	T-U	T-L	
Climacograptus scharenbergi *Lapworth*	.....	.....	r	D	D	.....	
Stomatopora inflata *Hall* sp.	.....	.....	c	T	T	B-T	
Stictopora *cf.* elegantula *Hall*	.....	.....	r	T	.....	.....	
Callopora multitabulata *Ulrich*	.....	.....	cc	.....	.....	B-T	
Prasopora simulatrix *var.* orientalis *Ulrich*	r	.....	.....	T	T	B-T	
Siphonotreta minnesotensis *Hall & Clarke*	.....	.....	rr	.....	.....	Lo	
Crania *cf.* trentonensis *Hall*	.....	.....	r	T	.....	T	
Pholidops trentonensis *Hall*	.....	.....	r	T	.....	T	
Rafinesquina alternata *Emmons* sp	cc	r	c	T-L	Ch-L	B-R	T of Manitoba
R. deltoidea *Conrad* sp	r	.....	.....	T	T	T	Lake Winnipeg Europe ?
Leptaena rhomboidalis *Wilckens*	r	.....	c	T-Carb	T	T-Carb	Europe
Plectambonites sericeus *Sowerby* sp.	.....	.....	c	T-L	Lo-L	Lo-R	Europe
P. sericeus *var.* asper *James*	cc	.....	.....	T-U	?	U	
P. pisum *sp. nov.*	r	.....	cc	.....	.....	.....	
Christiania trentonensis *sp. nov*	.....	.....	c	.....	.....	.....	
Triplecia nucleus *Hall*	c	r	.....	T	.....	.....	
Orthis tricenaria *Conrad*	c	.....	c	T	Lo-T	Lo-T	Baffin Land Lake Winnipeg
Plectorthis plicatella *Hall*	c	.....	.....	T	Lo-T	T-L	
Platystrophia biforata *Schlotheim* sp.	.....	.....	c	T-L	Chazy — Upp. Sil	T-R	Baffin Land Europe
Dalmanella testudinaria *Dalman* sp	c	r	c	Lo-L	Lo-L	Lo-R	Baffin Land Europe

Frequency and vertical range of species (*continued*)

	Gray lime-stone	Reddish gray lime-stone	Black lime-stone	N. Y.	Canada	West	Other regions
D. subaequata *var.* pervetus *Conrad*	c	.....	.....	T ?	Lo-B	Lo-B	
Dinorthis pectinella *Emmons* sp	r	.....	.....	T	Lo-T	B-T	
Parastrophia hemiplicata *Hall*	r	.....	.....	B-U	T	T	Baffin Land Lake Winnipeg
Protozyga exigua *Hall*	c	.....	.....	B-T	.....	Lo-T	
Zygospira recurvirostris *Hall*	c	.....	.....	B-T	Lo-T	Lo-T	
Modiolopsis aviculoides *Hall*	r	.....	.....	T	.....	.....	
Whitella ventricosa *Hall* sp	.....	.....	rr	B-T	T	T ?	
Ctenodonta *sp. indet*	.....	.....	rr	.....	.....	.....	
C. *cf.* astartaeformis *Salter*	.....	.....	r	.....	.....	.....	
Protowarthia cancellata *Hall* sp	.....	.....	r	T-L	T-L	B-R	
Conradella compressa *Conrad* sp	r	.....	r	T	Lo-T	.....	
Carinaropsis carinata *Hall*	c	r	r	T	.....	.....	
Lophospira bicincta *Hall* sp	c	.....	r	T	Lo-T	Lo-T	
L. perangulata *Hall* sp	c	.....	.....	Lo	.....	Lo	
Liospira americana *Billings* sp.	.....	.....	rr	B-T	Lo-T	Lo-T	Baffin Land
L. subtilistriata *Hall* sp	cc	.....	.....	T base	.....	.....	
Clathrospira subconica *Hall*	c	.....	.....	T	Lo-L	Lo-R	
Trochonema umbilicatum *Hall* sp	c	.....	.....	Lo-T	Lo-T	Lo-T	Baffin Land
Eccyliopterus spiralis *sp. nov*	.....	.....	rr	.....	.....	.....	
Holopea paludiniformis *Hall*	.....	.....	rr	T	.....	T	
Cyrtospira attenuata *sp. nov*	rr	.....	.....	.....	.....	.....	
Hyolithes rhine *sp. nov*	rr	.....	.....	.....	.....	.....	
Conularia trentonensis *Hall*	.....	.....	rr	T	.....	.....	
Spyroceras bilineatum *Hall* sp.	?	.....	.....	T	Lo-T	Lo-T	
S. *cf.* anellum *Conrad* sp	r	.....	.....	T	Lo-T	B-T	
Cyrtoceras subannulatum *Hall*	rr	.....	.....	T	Lo-T	.....	
Zitteloceras hallianum *d'Orbigny* sp	.....	.....	rr	T	T	B	
Tretaspis reticulata *sp. nov*	.....	.....	cc	.....	.....	.....	*cf.* Tretaspis Europe
T. diademata *sp. nov*	.....	.....	rr	.....	.....	.....	cf. Tretaspis Europe
Ampyx (Lonchodomas) hastatus *sp. nov*	.....	r	cc	.....	.....	.....	*cf.* Ampyx rostratus *Sars.* of Europe
Remopleurides linguatus *sp. nov*	rr	r	cc	.....	.....	.....	
R. tumidulus *sp. nov*	.....	rr	.....	.....	.....	.....	
Isotelus maximus *Locke*	cc	.....	c	B-L	T-L	T-R	Baffin Land Europe
Gerasaphes ulrichana *Clarke* sp	.....	r	.....	.....	.....	Lo-U	
Illaenus americanus *Billings*	c	.....	c	Lo-T	T	T	Baffin Land Europe ?
Thaleops ovata *Conrad*	r	.....	.....	.....	Lo	Lo	
Cyphaspis matutina *sp. nov*	.....	.....	r	.....	.....	.....	
Bronteus lunatus *Billings*	.....	.....	rr	.....	T	T	
Calymmene senaria *Conrad*	.....	.....	rr	T-L	T-L	T-R	
Pterygometopus eboraceus *Clarke*	r	.....	.....	T	.....	.....	
P. callicephalus *Hall*	c	r	c	T	T	Lo-T	
Ceraurus pleurexanthemus *Green* sp	c	.....	c	T	Lo-L	Lo-T	
Dalmanites achates *Billings*	c	.....	.....	T	T	T	
Sphaerocoryphe major *sp. nov.*	.....	.....	r	.....	.....	.....	Lake Winnipeg ?
Cybele *sp*	rr	.....	.....	.....	.....	.....	
Leperditia fabulites *Conrad*	c	.....	.....	Lo-T	Lo-T ?	Lo	
L. resplendens *sp. nov*	cc	c	.....	.....	.....	.....	
Isochilina armata *var.* pygmaea *var. nov*	.....	r	r	.....	.....	.....	Isoch. armata Lo-B of N. Y.
Schmidtella crassimarginata *var.* ventrilabiata *var. nov*	.....	cc	.....	.....	.....	.....	Sch. crassim Lo. in west
Primitia mundula *var.* jonesi *var. nov*	.....	.....	r	.....	.....	.....	

Frequency and vertical range of species (*concluded*)

	Gray limestone	Reddish gray limestone	Black limestone	N. Y.	Canada	West	Other regions
Aparchites minutissimus *var. robustus var. nov*	.....	.....	c	.....	.....	.....	
Eurychilina reticulata *Ulrich*	.....	c	.....	.....	.....	Lo-B	
E. bulbifera *sp. nov*	r	r	.....	.....	.....	.....	
E. (?) solida *sp. nov*	.....	rr	.....	.....	.....	.....	
E. subradiata *var.* rensselaerica *var. nov*	c	c	.....	.....	.....	.....	E.subradiata Lo.
E. obliqua *sp. nov*	rr	.....	.....	.....	.....	.....	
E. dianthus *sp. nov*	c	.....	.....	.....	.....	.....	
Bollia cornucopiae *sp. nov*	rr	.....	.....	.....	.....	.....	
Macronotella ulrichi *sp. nov*	c	.....	.....	.....	.....	.....	
M. fragaria *sp. nov*	rr	.....	.....	.....	.....	.....	
Bythocypris cylindrica *Hall* sp.	c	cc	r	.....	U	T-U	

TAXONOMIC RELATIONS OF THE FAUNAS

Compact black limestone

A comparative study of the vertical ranges of these fossils gives the following results for the fauna of the black compact limestone pebbles (group 5).

In this compilation of the vertical ranges, the more complete data obtained by the careful investigations of the western lower Siluric faunas by Clarke, James, Miller, Sardeson, Schuchert, Ulrich, Winchell, and others, have been largely used, as the New York lower Siluric faunas, since the days of Hall's preparation of the first volume, *Palæontology of New York*, have been practically left untouched, and the very important work of the exact fixation of the ranges of the lower Siluric forms and of the more definite subdivision of the beds has only lately begun. It is therefore assumed that forms which in the west or in Canada have been found to reach below or above their zone in New York, will with farther investigation also be found to have a wider range in this state. A glance at the preceding table will show that a great number of forms reported only from the Trenton of New York and Canada, are claimed to occur in the Ohio and upper Mississippi basins in beds corresponding to the Lowville and Black river limestones. This is evidently due to the relatively poor development of these last two terranes in the east.

Diplograptus foliaceus passes from the Chazy into

the Lorraine, Rafinesquina alternata in Canada from the Chazy into the Lorraine, Platystrophia biforata from the Chazy in Canada to the upper Siluric in the west.

These, as well as the new forms, can therefore be excluded as furnishing no data for the determination of the taxonomic position of this fauna. Also Climacograptus scharenbergi is of no use for this purpose, as it has hitherto been found only in another facies, the Quebec and Normans kill shales, and Stictopora cf. elegantula, Crania cf. trentonensis, Siphonotreta cf. minnesotensis, and Conularia cf. trentonensis are not positively identified. Of the remaining members of the fauna, Plectambonites sericea, Dalmanella testudinaria, Ceraurus pleurexanthemus range from the Lowville limestone to the Lorraine or Richmond beds. Orthis tricenaria, Lophospira bicincta, Liospira americana, Illaenus americanus and Pterygometopus callicephalus begin in the Lowville beds and rise into the Trenton. These, together with all the forms mentioned below which are younger, prove the black compact limestone to be younger than the Chazy, in spite of the Chazy aspect of some of its trilobites. Stomatopora inflata, Callopora multitabulata, Whitella ventricosa, Protowarthia cancellata, Isotelus maximus lived either in New York, Canada or the west from the Black river into the Trenton period. Streptelasma corniculum, Pholidops trentonensis, Leptaena rhomboidalis, Conradella compressa, Carinaropsis carinata, Zittelocerashallianum, Calymmene senaria, Bronteus lunatus and Bythocypris cylindrica have not yet been found below the Trenton. None of the species obtained from the black compact limestone is restricted to the Lowville or Black river limestone; it must, therefore, be concluded, that these pebbles are of Trenton age. The inquiry for the more precise location of the bed within the Trenton terrane meets with the greatest difficulty from the lack

of any definite facts as to the exact location and range of the Trenton fossils in the various outcrops within the state.

Of the fossils enumerated, those entering the Trenton or beginning in the Trenton would be available for an analysis; of these, however, Leptaena rhomboidalis, Lophospira bicincta, Liospira americana, Pterygometopus callicephalus, Stomatopora inflata, Whitella ventricosa, Protowarthia cancellata, Isotelus maximus, Illaenus americanus, Conradella compressa, Calymmene senaria, Bythocypris cylindrica are found to occur in one or another locality of the lower, middle or upper Trenton, and are thus unable to give the desired clue. Of the remaining species, Streptelasma corniculum is reported by Hall to occur principally in the lower Trenton, Orthis tricenaria in the lower Trenton in New York, while in Minnesota it is also found in the middle third of the Trenton; Callopora multitabulata is in Minnesota positively known from the lower Trenton and doubtfully from the middle Trenton, Pholidops trentonensis is of uncertain position at Middleville, a small variety of the same species is however in the west restricted to the lower Trenton, Carinaropsis carinata probably is restricted to the lower and middle Trenton of New York; and Zitteloceras hallianum is a Black river fossil in the west and was known to Hall only from the lower Trenton at Middleville.

Bronteus lunatus was described by Billings from the Trenton of Ottawa; according to the *Geology of Canada* (p. 177) it is associated there with a most remarkable fauna of crinoids and asteroids, only about 150 feet below the base of the Utica beds, while in the same work (p. 173) it is also reported from Murray bay together with such lower Trenton forms as Orthis tricenaria, Dinorthis pectinella, in a section giving 200 feet of limestone above the Black river beds. It appears, hence, to occur in the lower and upper third of the Trenton, while Clarke reports it also from the middle third of the

Trenton in Minnesota. Isochilina armata Walcott, var. pygmaea is a variety of a species which has been found by its discoverer only in the Lowville and Black river limestone of Russia, Herkimer co., while Primitia mundula and Aparchites minutissimus are later forms with prenuncial varieties in the Trenton. The evidence afforded by these fossils is obviously strongly indicative of lower Trenton age of the compact black limestone; for it must be considered that the great majority of the forms begin in the Lowville and Black river limestone and rise into the Trenton, while few begin in the Trenton and have their principal development in younger beds; some forms, as Streptelasma corniculum, Callopora multitabulata, Zitteloceras hallianum, and Isochilina armata var. pygmaea, can be regarded as restricted to the lower Trenton, or having their principal development there. The general appearance of the fauna of the compact black limestone pebbles, is hence, such as points more to a close relation with faunas older than the Trenton, than with younger faunas, and is, in a general sense, indicative of lower Trenton age.

Reddish gray and gray pebbles

A comparison of the faunas of the compact reddish gray (group 6) and of the gray crystalline limestone (group 7) pebbles shows that the two differ only in their ostracode element; the reddish gray limestone contains only a few other fossils, all of which, with the exception of Ampyx hastatus, Gerasaphes ulrichana, Pterygometopus calliceph-alus, occur also in the gray limestone. The ostracodes peculiar to the reddish gray limestone are either new species or new varieties, with the exception of Eurychilina reticulata. As, further, lithologic transitions from one to the other occur in the same pebble, it is apparent that both are derived from adjoining or alternating beds, and that it will serve our purpose to treat both faunas together.

Of the large number of species identified in these pebbles, the new species and Rafinesquina alternata, on

account of its great vertical range, will be left out of consideration. Also, Modiolopsis cf. aviculoides and Spyroceras cf. anellus are of little taxonomic value, being poorly represented and not positively identified.

Orthis tricenaria, Dalmanella testudinaria, D. subaequata var. pervetus Conrad, Plectorthis plicatella, Dinorthis pectinella, Protozyga exigua, Zygospira recurvirostris, Lophospira bicincta, Clathrospira subconica, Trochonema umbilicatum, Gerasaphes ulrichana, Illaenus americanus, Pterygometopus callicephalus, Ceraurus pleurexanthemus and Leperditia fabulites extend partly in the eastern and partly in the western province, from the Lowville limestone into or above the Trenton limestone, and serve, in the determination of the age of the pebbles under consideration, by a process of elimination, to prove that the fauna to which they belong originated in the Trenton period, and may belong either to the Lowville, Black river, or Trenton epochs. Parastrophia hemiplicata ranges from the Black river into the Utica beds, Conradella compressa from the Black river into Trenton beds, Isotelus maximus from the Black river into the Richmond beds.

Several members of the fauna of the gray limestone pebbles are thus far known only from the oldest epochs of the Trenton period; these are Lophospira perangulata Hall sp. Hall comprised two different forms under this one specific term; that found in the conglomerate agrees more with the Lowville limestone type than with the Trenton limestone type. Thaleops ovata occurs in the west only in beds of Lowville limestone age, and in Canada in beds in which the Lowville and Black river stages have not been separated.

Isochilina armata var. pygmaea is a variety of a species found by Walcott in the Black river and Lowville limestones, Schmidtella crassimarginata var. ventrilabiata, and Eurychilina subradiata var.

rensselaerica are slightly differing eastern representatives of western Lowville limestone forms, while Eurychilina reticulata is known only from the Lowville and Black river limestones[1].

There are, on the other hand, a number of forms which combat a conclusion based on the evidence just cited. These are: Rafinesquina deltoidea, reported from the Trenton of New York, Canada and the west; Triplecia nucleus, Carinaropsis carinata, Liospira subtilistriata, Pterygometopus eboraceus, Dalmanites achates, which are as yet known only from the Trenton limestone; Leptaena rhomboidalis and Bythocypris cylindrica, which begin in the Trenton and extend upward. Of these Rafinesquina deltoidea is only weakly represented by a form showing certain varietal differences in the suppression of the intermediate finer striae and concentric wrinkles on the disk, and is therefore probably not to be relied on as a safe indicator of the taxonomic relations of the beds under consideration; Triplecia nucleus, Carinaropsis carinata, Liospira subtilistriata and Pterygometopus eboraceus are not reported from extralimital localities, and, considering the fact that in New York the Lowville and Black river faunas are rather meager, and have been thoroughly investigated in but a few localities, they may possibly go below the Trenton limestone. This is specially probable in the case of Liospira subtilistriata, which is reported by Hall as occurring only near the base of the Trenton limestone at Watertown; but as Triplecia nucleus, Carinaropsis carinata and Liospira subtilistriata are characteristically developed and common in the limestone pebbles, they must be considered as important factors of the fauna of the latter and, with our present knowledge of their ranges, as indicative of the Trenton age of the gray limestone. Pterygometopus eboraceus has thus far

[1] The specimen from the Onondaga chert of New York referred by Jones (Quar. jour. geol. soc. 1890. 46:593) to this species is considered by Ulrich as specifically if not generically different.

been found only in one specimen in the Trenton of Saratoga county, and, for this reason, has little taxonomic weight, while Dalmanites achates, Leptaena rhomboidalis and Bythocypris cylindrica, having a wider distribution, must be considered as strongly supporting the view of the Trenton age of this fauna, suggested by the fossils just named.

In weighing the evidence furnished by the two groups of fossils, those which have their typical development in the lower epochs of the Trenton period, and those which are restricted to the Trenton limestone itself, it is to be considered that the Lowville and Black river limestone element is largely represented by ostracodes which, having been carefully studied in the west and found to be quite markedly restricted to certain horizons, must be regarded as fairly reliable horizon-markers. The forms from the conglomerate bed of Rysedorph hill, however, show, with the exception of Eurychilina reticulata, certain differences from the western types which, it is true, may be more the expression of difference of province than of epoch, but, in the face of the strong Trenton limestone element with which they are associated, can not be considered as furnishing conclusive evidence.

We have therefore somewhat conflicting evidence as to the age of these beds, which in the writer's opinion is due partly to the fact that the ostracode forms of the Trenton limestone of New York have not yet been thoroughly collected and studied, and partly due to the smallness of the fauna known as yet from the Lowville and Black river limestones of this state, specially from the former. All that can be said, therefore, at present in regard to the taxonomic relations of the fauna of the gray crystalline and associated reddish gray compact limestone pebbles is that they contain a Trenton fauna, with a strong Lowville and Black river element, and that, on this account, they evidently must be placed within the lowest Trenton; a conclusion which seems to be strengthened by the presence of a number of forms of lower Trenton occurrence, and the fact that the great majority of all forms observed range from the Lowville to the

Trenton limestone, instead of ranging from the Trenton limestone upward, so that the general aspect of the whole assemblage of forms is decidedly that of a fauna of the lower and middle part of the Trenton period.

Relative position of the black and gray Trenton limestones

In regard to the relative original position of the black compact Trenton limestone and gray crystalline and reddish gray compact Trenton limestone, which are mixed in the conglomerate, it is to be remembered that the black limestone pebbles, in spite of their strong admixture of strange types such as Ampyx and Remopleurides, fail to show such a decided Lowville and Black river limestone element as the gray limestone, and therefore should be considered younger than the latter. This conclusion is supported by the observation of several members of the black limestone fauna in the matrix of the conglomerate at the Moordener kill and at Schodack Landing, as shown in the following tabulation.

Fauna of matrix

	Moordener kill	Schodack landing [1]	Occurrence of fossils in pebbles
Streptelasma corniculum	.....	+	black Trenton limestone
Pachydictya *sp*	+	.....	
Stromatocerium *sp*	+	.....	
Rafinesquina alternata	+	+	black and gray Trenton limestone
Strophomena incurvata	+	.....	
Plectambonites sericeus *var.* asper	+	+	gray crystalline Trenton limestone
P. pisum	+	+	black Trenton limestone
Orthis tricenaria	.....	+	black Trenton limestone
Pterygometopus callicephalus	+	.....	gray and black Trenton limestone

This faunule would suggest that the conglomerate beds were formed at a time when the organisms found in the black compact limestone were still flourishing, and that both must be considered as falling within the same epoch, viz the lower Trenton.

[1] The matrix of the Rysedorph hill conglomerate, which is more sandy than that of the more southern exposures, is filled only with comminuted fragments of Rafinesquina alternata, Plectambonites sericeus, etc.

Some other observations materially support this conclusion. Foremost of these is the occurrence of Climacograptus scharenbergi in the black limestone. This graptolite, as already remarked in another paper, is a typical form of the lower and upper Dicellograptus zones in Canada, and of the corresponding beds in Great Britain, and is in New York restricted to the lower Dicellograptus zone or Normans kill shale. As the conglomerate bed is intercalated in this shale, it is evident that the formation of the conglomerate and of the shale are, geologically speaking, contemporaneous, and, as this graptolite of small vertical range occurs also in the black limestone pebbles, the formation of that limestone must also be nearly contemporaneous with, or, more exactly speaking, precede the formation of the conglomerate within the same subdivision of the Trenton limestone epoch.

The formation of that part of the Normans kill shale lying below the conglomerate bed, and of the black Trenton limestone have, in the writer's opinion, been synchronous and going on in adjacent regions, the black limestone representing the limestone facies corresponding to the shaly Normans kill graptolite facies.

The remarkable coincidence of the existence of numerous faunistic elements, strange to the continental Trenton of North America, in both the shales and the black limestone, will be further discussed in the next section, but may be mentioned here as additional argument in favor of the equivalency of the faunas of the Normans kill shales, and of the black Trenton limestone of the conglomerate.

Faunistic difference between the lower Trenton of New York and the west

In a previous paper the writer has already discussed the difference in sedimentation and fauna between the lower Trenton as represented by the Normans kill graptolite shales of the Appalachian region and lower Canada and the lower Trenton limestone of the regions farther west.

The observation of a succession of terranes from west to east in Albany county, which proved to represent the Lorraine, Utica, middle Trenton and Normans kill graptolite epochs, forms the basis of the claim that the last must be homotaxial with part of the lower Trenton limestone of the regions farther west. It was further demonstrated by the observations of Prosser and Cumings that the Trenton limestone thins out gradually from the type section at Trenton Falls toward the Hudson river, while at the other side of that river, according to the observations of Walcott, Dwight and Dale, the Trenton epoch is only slightly represented by calcareous deposits, and these most probably belong only to the lowest Trenton. It is, hence, quite certain that the Trenton in this part of the Appalachian region is largely represented by clastic sediments.

This distinct lithologic development is associated with an entirely different faunistic facies, the Normans kill graptolites in association with a few small brachiopods constituting the only evidences of life in these lower Trenton shales. It has been pointed out that this peculiar graptolitic fauna has been traced from Lower Canada, where it was studied by Lapworth, through Maine, Vermont, and along the Hudson river in New York, and probably, as maintained by Emmons, extends as far as Virginia. While it has been identified by Lapworth with a fauna of wide extent in the lower Siluric of Great Britain and Scandinavia, it has not been recognized in its typical development west of the Appalachian region, though apparently reappearing in Arkansas and British Columbia. The consensus of opinion of recent writers on this graptolite fauna is that it was of oceanic and probably planktonic habitat. Its distribution on both sides of the Atlantic basin indicates its extent over a large part of that basin. The black bands filled with graptolites are in most of the localities, hidden away in a huge mass of more sandy shales and thin beds of sandstone, suggesting thus that the myriads of these living beings were swept together only accidentally. The astonishing scarcity of complete colonies among the endless numbers of

rhabdosomes of a considerable number of species[1] is a forcible indication that they had fallen to the sea floor and drifted about outside of their habitat. The assumption that the rhabdosomes were carried by currents either oceanic, tidal or coastal, and deposited, as suggested by Lapworth, in the quiet water at a certain, more or less uniform, distance from the coast, can therefore not be far from the truth. We must conclude from their meridional distribution that they were brought into the Appalachian region from the Atlantic basin, while the far west received them from the Pacific basin.

Lower Trenton faunas of the central and eastern coastal regions with European elements

The question of the probable route along which this incursion took place, may at present be disregarded, and the mere fact be emphasized that there exists a wide difference between the fauna and sedimentation of part of the lower Trenton in the eastern coastal region, and that of the eastern inland region. This difference may be only one of facies, that is, a difference in faunal composition causally connected with the difference in sedimentation, and may indicate nothing but difference of depth, distance from the coast line or swiftness of current, such differences as are found within close limits along all coasts, and affect only small areas. Or it may be one of provincial importance caused by the differences of the conditions existing between different parts of the ocean, or the latter and its border seas.

The wide extent of the Normans kill graptolite fauna and its restriction to the eastern continental borders on one hand, and the greater extension of the synchronous Trenton limestone and its restriction to the continental platform, suggest that we have here a difference of provincial importance. It is therefore a fact of much interest that there is found entombed in the conglomerate a limestone fauna which must have existed shortly

[1] To illustrate this scarcity of colonies, it may be mentioned that in a dozen boxes of selected material secured in a week's collecting at Mt Moreno near Hudson, not a single colony was found, though all the species of the horizon are represented by rhabdosomes in finely preserved state. The same experience has been repeatedly met with by the writer, as well as others, in all localities of this zone.

before or contemporaneously with the lower part of the shale, as indicated by the presence of one of the characteristic graptolites of the shales and the lower Trenton aspect of the entire assemblage. In this limestone fauna, then, we have a direct means of comparing lower Trenton forms of the eastern border and of the continental sea, living in the same bathymetric zones and under the same marine conditions, and of determining whether the incursion of the eastern graptolite fauna into the continental border sea indicates the opening of an entirely new but temporary connection with the Atlantic ocean, or whether Atlantic, or rather European connections have had an appreciable influence also on the faunas of the limestone-depositing Trenton sea. The latter suggestion is in a certain measure supported by the appearance of the Normans kill graptolites in the limestone, but, in order to establish the conclusion, it is, in the writer's belief, fully demonstrated by a number of other fossils appearing in the limestone.

The species on which this conclusion is mainly based are, besides the above mentioned graptolites, whose habitat is the eastern border region and northern Europe: Christiania trentonensis sp. nov., which is well represented in the lower Siluric of Europe, by closely similar species, though in America only known heretofore by a Helderbergian species; the two species of Tretaspis, a genus unrepresented in the American Trenton fauna but widely and richly represented by allied species in the lower Siluric terranes of Great Britain, Bohemia and Scandinavia; Ampyx hastatus, which belongs to a subdivision of that genus (Lonchodomas), not represented in the Trenton of North America, but present at this time in northern Europe (Ampyx rostratus); the species of Remopleurides, which have not been found in the central continental region; the Sphaerocoryphe, which thus far is definitely known only from this locality, and which also is a foreign element to the Trenton of North America. Remopleurides striatulus Walcott, and Sphaerocoryphe robustus Walcott, occur at Trenton Falls only in higher

beds, but have not been observed farther west. They are evidently survivors clinging to the eastern region. The pygidia of Cybele observed at Rysedorph hill and stage N of the Quebec group in Newfoundland belong to forms closely related, if not identical with the European Cybele verrucosa.

There are still other differences in these faunas manifested in the distribution of forms known before. Thus the genus Triplecia, occurring in the lower Trenton pebbles of Rysedorph hill, is represented in the Trenton of New York by three species, while, according to Schuchert's *Synopsis of American fossil Brachiopoda* and Winchell and Ulrich's lists, it is not found in Trenton beds west of New York, but appears in the central region in Lorraine time and continues into the Niagara period. In Europe several species from the lower Siluric have been referred to this genus, one of which, Triplecia spiriferoides McCoy, from the homotaxial Llandeilo, belongs to the radiated group represented in the eastern Beekmantown limestone. Orthis insularis Eichwald is also regarded as a Triplecia by Hall and Clarke. This ranges from the Llandeilo to the upper Llandovery. It is therefore probable that the peculiar distribution of this genus in the Trenton of America indicates zoogeographic differences between the eastern border and the more continental Trenton, due to the exchange with the faunas of more easterly regions.

Trinucleus concentricus has been recorded from the lower Trenton of New York (White, p. 84) and abounds in the upper strata of this formation, but it does not appear as a Trenton species in the lists of Minnesota fossils given by Winchell, Ulrich and Clarke. In the Ohio valley it pertains to the upper beds only (i. e. upper Trenton and Richmond). This species seems to have slowly spread from east to west into the continental basin. No other species of this genus is known in the North American lower Siluric, with the exception of a small Utica form, separated by Ulrich, while in Europe quite a number of lower Siluric species have been described. These facts appear

to indicate that this genus had its center of development farther east, either in the Atlantic or in northern Europe.[1]

ORIGIN OF THE CONGLOMERATE

The origin and composition of the conglomerate bed, whose fauna has here been investigated, invites some farther remarks. The bed is composed of pebbles of lower Cambric, Chazy, Beekmantown and lower Trenton age. The explanation of this remarkable accumulation is largely to be found through an inquiry into the direction whence these pebbles came.

The extremely rare lower Cambric pebbles are identical with those of the lower Cambric conglomerate exposed at Troy and Schodack Landing. They may therefore be derived either from that conglomerate bed or from the mother bed of that conglomerate. They can not be derived from the west or northwest, as no lower Cambric beds are known in those directions, while they are known in the regions to the north and east. Neither is the Chazy known farther west, nor in the Mohawk region; it extends largely to the north in the Champlain region and is quite certainly present in the limestones of the Taconic region. The Lowville limestone and gray lower Trenton limestone pebbles may be derived from the west. It is not to be assumed that the materials of the conglomerate were gathered from different or even opposite directions; and, as the lower Trenton is also well exposed to the north and south, and is supposed to form a part of the metamorphic rocks in the Taconic region to the east, it is more than probable that these were derived from the east or north rather than from the west. Finally the black Trenton lime-

[1] The forms cited here constitute an element in the Trenton fauna of eastern America which is evidently more fully represented in the homotaxial beds of northern Europe. As the latter, and specially the European northwest, was at that time a part of the Atlantic basin, the presence of these forms must be taken to indicate some connection of the continental Trenton sea with the Atlantic in the northeast.

If the "Grönländischer continent", supposed by Prof. Frech to have extended in lower Siluric time across the present northern Atlantic from Baffin Land and Labrador to Scotland and Scandinavia, was a reality, its southern coast would have furnished either the center of development or the highway for the migrations of these forms and many others, as *Asaphus gigas*, *Calymmene senaria*, *Plectambonites sericeus*, *Platystrophia biforata*, *Dalmanella testudinaria*, *Orthis tricenaria*, *Leptaena rhomboidalis*, which appear in lower Siluric time on both sides of the Atlantic.

stone pebbles, with their peculiar faunal elements, are quite distinct from the Trenton exposed in the Mohawk valley, nor have similar Trenton fossils been recorded from more northerly, or southerly localities.

The sum of the evidence points, therefore, to an origin of the conglomerate pebbles from a direction other than the west, or to the area of Appalachian folding between the lower Mohawk and Taconic mountains.

The tectonic events of lower Siluric time have been described with a master's hand by Dana:

> The era of limestone-making and therefore of continental seas, largely free from sediments, which made progress in the Canadian period, reached its culmination in the earlier division of the Trenton period, when limestones were almost the only kind of rock being deposited over the breadth of the continent. The absence of sediments from a large part of the continental region must have been owing to the absence of the conditions on which their distribution depends. The currents of the ocean which ordinarily swept over the land (the Labrador currents from the north, along the eastern borders, and the Gulf stream from the south, over the interior) must have had their action partly suspended. This may have been caused by a barrier outside of the limestone area, near or outside of the present Atlantic coast line. If the land in the shallow region outside of the present Atlantic border of the continent, were above tide level at the time, it would have been a continental barrier against both waves and currents.
>
> With the opening of the Hudson river era, sediments again were deposited over New York and the Appalachians, and some change of level had therefore taken place. But, as the formation of the limestones was continued in the Mississippi basin, and also in the St Lawrence bay (at Anticosti), the change did not affect essentially these regions. If the Atlantic barrier above alluded to were a fact in the Trenton era, an oscillation of level submerging it, and raising toward the surface another parallel region more to the west, where the Appalachians now stand, would have opened again the New York and Appalachian area to the ocean, and so might have occasioned the transition to sedimentary accumulations.

The barrier, assumed by this profound student, to account for the undisturbed deposition of the lower Lower Siluric up to the

end of the Trenton, is represented by Frech on his chart[1] drawn to explain the complete faunistic differentiation of the American continental and North Atlantic basins from the beginning of the lower Siluric to the end of the Black river limestone period. Frech there assumes an oceanic transgression in the Appalachian regions to connect the Trenton with the European faunas, while Dana has the barrier migrate westward at the end of the Trenton period to explain the transition to clastic accumulations. The writer in the foregoing chapters, has brought more evidence to demonstrate the ingress of Atlantic forms into the eastern part of the Trenton basin at the beginning of the Trenton period, and has elsewhere shown that, in this part of eastern New York or in those parts of the Appalachian area where the Normans kill shale is found, the transition to the deposition of clastic sediment began in the early Trenton period and not toward its end.

If we attempt to apply to our investigation into the origin of the conglomerate the theories set forth by these authors, we may infer that at the beginning of the Trenton period the deposition of limestone continued for a short period in this region, and the material of the gray limestone pebbles of lowest Trenton aspect was formed; that at this time, by the incipient transgression of the ocean over the eastern barrier, the influence of north Atlantic forms began, becoming more pronounced at the time of the deposition of the black limestone; that, at the same time, the gradual rising of the more westerly parallel barrier in the Appalachian region, together with the numerous Archaean islands assumed by Dana, furnished the material for the long belt of Normans kill shale and the conglomerate bed. The very extension of the Normans kill shale from north to south would indicate the direction of this barrier and of the intercalated conglomerate bed as that of a probable coast line.

This attempt to account for the presence and the peculiarities of the conglomerate bed is partly supported by a view advanced by Walcott to explain the origin of intraformational conglomerate beds of Cambric and earliest lower Siluric age observed

[1] Roemer & Frech. Lethaea palaeozica. 1897. v. 3, Karte 2.

in a number of localities in the Appalachian region[1]. The occurrence of conglomerate beds resting on the limestones from which they were derived, suggested to that experienced observer that the sea bed was raised in ridges or domes above the sealevel, and thus subjected to the action of seashore ice, if present, and the aerial agents of erosion. While no direct connection has been noted between the lower Trenton conglomerate and the youngest limestone bed represented in it, the assumption of the presence of such ridges or domes in the Appalachian region is in accord with our knowledge of the constant movements going on in this region throughout the Paleozoic era, and coincides with the assumption of barriers in this region made by other writers. It is therefore quite possible that the assumed transgressions opened the crest of one of these ridges or domes, and thus laid bare at once to the abrading action of the waves, a series of beds extending from the Cambric to the last deposited Trenton limestone, and furnished the various materials for the conglomerate and the calcareo-arenaceous mud of the matrix. These were deposited on the Normans kill shales forming in the deeper water.

While the presence of temporary coast lines, or the exposures of the various beds represented by the pebbles, to wave action, caused by the rising of broad ridges to the surface of the lower Trenton sea, may be inferred with some degree of certainty, the great variation in the size of the boulders and pebbles presents some difficulty to these attempts at explanation. Some of the boulders attain a diameter of several feet. The action of coast ice, appealed to by Dawson for the explanation of the lower Siluric conglomerates near the St Lawrence river and suggested by Walcott as an alternative theory for the origin of some of the Cambric conglomerates, may in the writer's judgment be excluded here on account of the presence of the Trenton fossils, including corals, in the matrix. But it is highly probable that the action of strong tidal or coastal currents, caused by the oblique impact of the waves on the coast, was engaged in spreading the material derived from the coastal or abraded region over a

[1] Geol. soc. Am. Bul. 1893. 5:191.

large area, as suggested by the relative thinness of the bed, and the transportation of large boulders. It is a matter of repeated observation that shingle, often of considerable size, is distributed widely along the coasts, when the two kinds of currents mentioned above are able to display their full force. The boulders and pebbles transported by such currents are reported to be of different size, varying according to their relative hardness. As the largest boulders in the conglomerate consist of very hard Lowville limestone, and the smaller ones of more friable sandstone or more brittle, black crystalline Trenton limestone and of softer gray Trenton limestone, the common conditions prevailing along the coast of an open sea seem to be sufficient to explain the phenomena of the Rysedorph hill conglomerate.

It has been lately urged by Gilbert van Ingen[1] that certain unsorted deposits, observed by Kümmel, Weller and himself in New Jersey, should not be considered as of submarine origin, but rather as flood plain deposits. The writer is convinced that this view will greatly aid in understanding the barren measures of several of our formations, but does not believe that it could be applied to the explanation of the Rysedorph hill conglomerate, for the following reasons:

The matrix of the conglomerate has been found to contain marine fossils, the bed is only relatively thin and intercalated in distinctly marine deposits; and, the Rysedorph hill beds show distinctly long strings of pebbles which indicate a certain assortment of the material. In some places these pebbles are still angular and appear as if belonging to a continuous bed broken up and at once recemented.

Other Trenton conglomerates

The extension of this conglomerate bed north and south beyond the localities described will be a subject for farther investigation. Prof. Dana and Prof. Dwight have made known the presence of a Trenton limestone farther south which is described as having

[1] N. Y. acad. sci. Oct. 15, 1900; Am. geol. Jan. 1901, p. 43.

a brecciated appearance. The Canadian geologists report the presence of conglomerate bands in the synchronous graptolite shale of Quebec; and Mr Kümmel and Dr Weller have discovered a conglomerate bed at the base of the Trenton in New Jersey. It is, however, more than doubtful that these occurrences have any relation to the bed in Rensselaer county, specially as the New Jersey conglomerate is considered a basal conglomerate, and that of Rysedorph hill is evidently intraformational, containing pebbles of the same epoch and intercalated in shales of the same epoch. It has, however, been demonstrated that a continuous stratum of conglomerate, over which, on a sinking coast, younger deposits creep, may belong to many successive horizons. This has been most clearly pointed out by De la Bèche in the southwest of England[1]. The New Jersey conglomerate may therefore be only apparently basal and actually synchronous with the more northern one.

As the study of the conglomerate beds of various formations and the investigation of the conditions along coasts where such beds are formed, has furnished ample evidence that conglomerates are the most inconsistent of all sedimentary formations, usually sinking or swelling up suddenly, thinning out and reappearing, it is also to be assumed *a priori* that the bed extending from Rysedorph hill to Schodack Landing is not of such a wide extent as to allow its connection with the beds of Quebec or New Jersey.

However that may be, the Rysedorph hill conglomerate continues to be remarkable as an intraformational conglomerate. A conglomerate, according to the experience of geologists, generally indicates a break in the continuity of the sedimentation, an erosion of a preexisting formation and, therewith, an important change in the physical conditions of the region. The writer feels however that the presence of true intraformational conglomerates in the Cambric and lowest lower Siluric of the Appalachian region has been so distinctly and vividly set forth by Walcott[2] that no reasonable doubt of the existence of this phe-

[1] Geikie. Textbook of geology. 1893. p. 516.

[2] Geol. soc. Am. Bul. 1893. 5: 191.

nomenon in this region, and even in Cambric beds close to the Trenton conglomerate, can be entertained. Farther, the inferences as to the origin of the intraformational conglomerate drawn by Mr Walcott from observations extended over the whole Appalachian region, seem to be applicable to the Rysedorph hill conglomerate. Mr Walcott had the opportunity of observing the relation of the bedded limestone to the superjacent conglomerate, a relation which proved that the calcareous mud which was subsequently consolidated into the limestone, solidified soon after deposition. "This is shown by the presence in the conglomerate of rounded pebbles and angular fragments of limestone with sharp clear-cut edges." The same observation has been made in the Rysedorph hill conglomerate as to the lower Trenton pebbles; and, as the same fauna has been found by the writer in the matrix and in one of the groups of limestone pebbles, the calcareous mud composing those pebbles must have consolidated during the continued existence of that fauna.

SUMMARY

1 The investigation of the lower Siluric shales of the neighborhood of Albany has led to the observation of a conglomerate bed embedded in these shales and outcropping on Rysedorph hill near Rensselaer, on the Moordener kill near Castleton and at Schodack Landing.

2 The most interesting feature of this conglomerate is the fauna which the component pebbles and the matrix contain. To describe these and to obtain from them conclusive data as to the age of the inclosing Normans kill shales is the principal purpose of this paper.

3 The conglomerate contains a great variety of pebbles. In the southern outcrops, at Schodack Landing, nonfossiliferous sandstone pebbles prevail; going northward, fossiliferous limestone pebbles increase, and on Rysedorph hill they are the principal components.

4 The limestone pebbles are shown by their faunas to be derived, in very small number, from Cambric and Chazy rocks;

more frequently from the Lowville limestone; and prevailingly from extremely fossiliferous black and gray limestone beds which are of lower or lowest Trenton age.

5 A specially interesting feature of the fauna of these Trenton pebbles was found in the considerable number of new forms, largely brachipods, trilobites and ostracodes. Some of these belong to genera new to the American Trenton but well represented by very similar forms in equivalent north European beds. These, as well as several other forms which also occur in the Rysedorph hill conglomerate and are restricted to the eastern Trenton, support the conclusion derived from the distribution of the Normans kill graptolite shales, viz that in lower Trenton time the eastern Trenton sea had attained connection with the Atlantic.

6 As the fauna of the Trenton pebbles is in marked features different from that of the beds known in the Mohawk and Hudson valleys, it is supposed that the material was derived from the regions to the east and northeast, where the Trenton beds have now become metamorphosed and the fossils obliterated.

7 The occurrence of the lower Trenton limestone pebbles in this region is taken to indicate that at the beginning of the Trenton period the quiet limestone-depositing Trenton sea extended also over this region; while the presence of the Normans kill shale of lower Trenton age proves that this favorable condition soon came to an end, and a radical change in the physical conditions took place.

8 The conglomerate itself is intraformational. It is embedded in shale of the same age, and the fauna of the matrix of the conglomerate is of lower Trenton age. The conglomerate, therefore, evidently does not mark any important change in the physical conditions of the region, but is probably due to a temporary elevation of a low Appalachian ridge into the sphere of wave action.

LIMESTONES OF CENTRAL AND WESTERN NEW YORK

INTERBEDDED WITH

BITUMINOUS SHALES OF THE MARCELLUS STAGE

WITH NOTES ON THE NATURE AND ORIGIN OF THEIR FAUNAS

BY JOHN M. CLARKE

Plate 8

The peculiar aspect of the fauna accompanying the dark Marcellus shales is familiar to every field worker in the geology of New York. It is a small congeries of diminutive and tenuous shelled creatures, such as Orbiculoidea minuta, Chonetes mucronatus, Liorhynchus limitare among the brachiopods, Actinopteria muricata, Pterochaenia fragilis and a few other shells among the lamellibranchs, usually referred to Lunulicardium and Panenka, the cephalopods Orthoceras subulatum, Parodiceras, and the pteropod Styliolina fissurella in great abundance. In all bituminous beds of like character in the older paleozoic there is a certain uniformity of expression in the faunas, a sort of convergence, no doubt induced in considerable measure by the circumstances under which the sediments were deposited and the organisms have existed. The latter, whatever their zoologic position, show evidence both in their small form and thin shell of having yielded in some degree to the unfavorable influences of a shallow sea in its influx on the epicontinental plateau. It is quite evident that the fauna, small as it is, is not homogeneous and can not represent a single bathymetric facies. We shall observe from the considerations following that, as a whole the fauna was introduced within the confines of New York before the cessation of Onondaga limestone deposition; furthermore present evidence seems to indicate that it was an invader from the southeast along the inner or Appalachian face of the interior sea.

In the common and historic employment of the term Marcellus shales as an expression of a lithologic unit, it has been usage to include therein whatever slight variation in sedimentation these

black shales may carry with them, and, so far as the main body of the formation is concerned, these variations consist in the appearance now and again of calcareous banks at various altitudes from the base of the formation, but more notably predominant toward the lower part of the mass.

All through the country west of Onondaga county the passage of the black shale upward is so gradual and the diminution of its bituminous matter so almost imperceptible that no division line between the Marcellus and Hamilton deposits is practicable, and no successful attempt has yet been made to delimit the two. Hence naturally a discrepancy appears in the assignments which have been made now and again of the thickness of the Marcellus deposits throughout this region.

From Onondaga county to Lake Erie the bituminous shales pass upward into and are overlain by a heavy mass of blue and barren shales, shown by the section in the Livonia salt shaft to be fully 200 feet thick, and these carry in regularly diminishing degree the characteristic species of the dark beds below.

The limestone beds which invite special attention at this occasion constitute two notable banks, both of which have accepted appellations, one the "Goniatite" or Agoniatites limestone, the other the Stafford limestone. These are persistent over very considerable distances along the strike, one of them curiously enough disappearing from the strata where the other makes its first appearance. The former (Agoniatite limestone) extends from Schoharie county on the east to about the meridian of Phelps, Ontario co., and the latter from Phelps to Lake Erie. There are at various exposures of the Marcellus shales other more restricted manifestations of calcareous deposits in thin beds which have afforded some interesting faunal variations. These will be briefly noticed in the following passages.

Evidence of the two chief limestone banks above noted was recorded by the early geologists, the Stafford limestone in the sections given by Prof. Hall[1], and the Agoniatite limestone in the descriptions by Vanuxem[2]. Though mentioned incidentally

[1] Geol. N. Y. 4th geol. dist. 1843. p. 178, 179, 183.

[2] Geol. N. Y. 3d geol. dist. 1842. p. 147, 149.

at that date, neither, in its character, extent and faunal contents, has been fully exploited till lately, nor has the interesting fact been sufficiently emphasized that both carry comparatively profuse faunas fundamentally unlike each other but evidently derived from the same direction, and quite unlike the normal fauna of bituminous shales.

STRATIGRAPHY OF THE AGONIATITE LIMESTONE

Madison and Onondaga counties

For the most part the outcrops of this rock in Madison and Onondaga counties are obscured by the soil mantle or, where seen in drainage sections, are of partial thickness and fail to disclose the actual relation of the beds to the involving shales[1].

There are several such small outcrops in the vicinity of Manlius. For example, the rock appears on the road from Eagle village to Chittenango not far from a schoolhouse at which a road turns north, about $\frac{1}{2}$ mile west of the west line of Madison county; and again about $\frac{1}{4}$ of a mile southwest of Eagle village in a small ravine. In another little ravine near the schoolhouse in district 8, southwest corner of the town of Manlius and about $1\frac{1}{2}$ miles west of the village on the road to Jamesville, the limestone forms the sill of a cascade, being in two layers, the upper about 1 foot thick and the lower nearly 2 feet. So great a thickness is rarely shown by the formation. The rock is hard and compact, specially at its contact above and below with the shales, and the characteristic large cephalopods (*Agoniatites expansus*, *Orthoceras marcellense*, etc.) of the formation are mainly in the lower part of the upper layer. About 100 rods farther west another small brook crosses the Jamesville road just at the intersection of a north and south road. Here the Onondaga limestone is considerably flexed, and over it lies a slight exposure in the bed of the creek and on the south bank. None of these exposures has afforded opportunity for an accurate measurement of the thickness of the Marcellus shales above and below the limestone.

[1] The sections in this region and in Cayuga and Ontario counties have at my request recently been reviewed by D. D. Luther, who has supplied much of the detail here given.

About ¾ of a mile southeast of Marcellus village is Dunk's hill, a knoll 40 or 50 feet high. The Agoniatite limestone appears here in a grade cutting on the west side of the hill and again in a field on the south side, and over a considerable area it is covered by only a thin layer of soil. Its thickness is 2 feet 6 inches in two layers. In the immediate vicinity of this locality are other outcrops which the searcher for the interesting fossils of the limestone would do well to exploit. It may be noted however, that frequently the rock is too deeply seamed and etched by weathering to justify the labor, often great, of attempting to collect from it. It is not only of impure character, but the purer calcareous matter is arranged in spots and patches in such a way as to afford least resistance to decomposing agencies. This is notably the nature of the rock in the exposures in Dunk's hill. Another small outcrop occurs in the side of the road about a mile farther toward Cedarvale and again across the valley toward the southwest, where the rock is very compact and lies close to the surface over a large area.

Slate hill is situated about ¾ of a mile southeast of Marcellus village, having the valley of Nine-mile creek on the west. It is composed of black and dark blue shales and shows on the north side along the road at its base a slight exposure of the Agoniatite limestone, and the dark calcareous shales beneath are exposed for a thickness of about 3 feet, on the south side of a neighboring depression. On the dugway road up the hill, black fetid shales are exposed to a thickness of about 20 feet, and above them on the west slope of the hill the upper blue black shales are shown. We shall observe in more westward sections that the horizon of the Stafford limestone is approximately at the junction of these bituminous beds with the blue black shales above.

Other outcrops occur about ½ mile east of St John's school, Manlius, and on the east and west sides of Onondaga Valley. On the west side near Dorwin's spring the rock is 130 feet lower

in actual elevation than at Jamesville and Manlius, a result of the low monocline traversing this region.[1]

About 3 miles west of Marcellus on the road to Mottville, town of Skaneateles, the Agoniatite limestone is very near the surface, but makes few if any well defined outcrops. Although the actual interval between the Onondaga and Agoniatite limestones is not afforded by any of the Onondaga county sections here observed we estimate it to be not far from 20 feet.

Cayuga county

One mile south of the village of Union Springs, and on the east side of the road leading to Levanna, is an abandoned quarry known as " Wood's old quarry". It is situated in the summit of a flat-topped anticline, the strippings extending pretty well down the sides. The cap rock in the quarry wall is the Agoniatite limestone, 22 to 24 inches thick and in its usual condition, very hard when fresh and dark, almost black in color, varying much in texture and purity and crumbling under the weather. It also contains a good deal of pyrite, which gives old blocks a rusty color. For these reasons it is of little use to the quarrymen and is stripped to reach the Onondaga limestone beneath. At the south end of this a slight thickness of black shales is seen above the limestone. Below, the succession to the Onondaga limestone is as follows: black shales with thin slabs of impure limestone, 3 feet; black shales and thin impure limestones in about equal proportion, 8 feet; impure limestone, 1 foot, 6 inches, with a shaly parting separating it from another layer of like character, 1 foot, underlain by 5 inches of soft black shale which rests on the Onondaga (35 to 40 feet thick) a total for the interval of about 14 feet. The argillaceous and impure limestones constituting the basal parts of these Marcellus strata are largely devoid of fossils, except Styliolina and plant spores, and the Agoniatite limestone itself is less abundant in its large cephalopods than in more eastern outcrops.

[1] Prin. J. D. Wilson read a brief account of the stratigraphy and fauna of this limestone in Onondaga county before the Onondaga academy of science, Mar. 25, 1901, and has kindly allowed me to make reference to the facts given in the above paragraph.

This limestone again appears in a small brook, ¼ of a mile south of Wood's quarry. In the outcrops along Criss creek, 2½ miles south of Union Springs, the strata above the horizon of the Agoniatite limestone are shown, and a point of interest in this section is the presence of a bed of 15 feet of blue and olive calcareous shales, lying above the general mass of darker shales, which carries certain trilobites (Homalonotus, Phacops), brachiopods, gastropods, etc. pertaining to the normal Hamilton shale fauna. These shales lie at about the proper horizon of the Stafford limestone, though no trace of this rock has been seen so far east.

Ontario county

The westernmost observed exposure of the Agoniatite limestone occurs on Flint creek, near the village of Phelps. The Lehigh Valley railroad crosses this creek and the Sodus Bay railroad by one bridge. On the south side of this bridge to the southernmost outcrop of Onondaga limestone and 50 rods south of the next highway bridge over the creek, there is a low ledge of the Agoniatite limestone in the bed of the stream. It is here in the usual condition and about a foot thick, underlain by dark impure and bituminous limestones of the same character as those observed at Union Springs but of considerably less thickness. The rock here contains *Agoniatites expansus* though poorly preserved, lying close above the Onondaga. Though the interval thence to the Onondaga limestone is not exposed it is evidently not in excess of 10 feet.

Genesee county

The collections of the state museum contain a specimen of *Agoniatites expansus* in a slab of the thin limestones which lie near the top of the Onondaga beds at Lime Rock. This specimen is an individual of large size though of poor preservation.

Erie county

The Lackawanna iron and steel co. has recently sunk shafts and constructed a waterworks tunnel at Stony Point on Lake Erie,

near the south line of Buffalo in the town of West Seneca. These shafts penetrate the rock to a depth of 64 feet and transect a soil covering of 26 feet. Of this rock section 49.6 feet are the black highly bituminous shales of the lower part of the Marcellus and beneath are 9.6 feet referred to the gray Onondaga limestone. Parts of the black shale are somewhat calcareous and bear the peculiar fauna at the base of the Marcellus section of the Livonia salt shaft, referred to more fully on a subsequent page. In the limestone beneath A g o n i a t i t e s e x p a n s u s has been found, associated with some small brachiopods which accompany it in its occurence at Cherry Valley.[1]

From the data given above we conclude that in the region west of Madison county to its extinction in Ontario county the Agoniatite limestone continuously approximates to the horizon of the Onondaga limestone and that still farther westward its horizon (the limestone itself having disappeared) actually coincides with and merges into that of the Onondaga limestone.

We now observe the following facts in its passage to its eastward extinction.

Otsego county[2]

Cox's ravine, which begins ¾ of a mile northwest of Cherry Valley, shows the following section at base.[3]

		Feet	Inches
1	Black fissile Marcellus shale with the usual fossils.	7	11
	Covered	7	4
2	Heavy, black shale with L u n u l i c a r d i u m m a r c e l l e n s e	2	8
	Covered	7	10
3	Heavy, black shale with large concretions	6	5
4	Limestone at	32	2

[1] Prof. I. P. Bishop directed my attention to these excavations in October of this year and has very kindly given me the rock section there exposed. Richard F. Morgan has at my suggestion made a collection of the organisms there thrown out. I am under obligations to both of these gentlemen.

[2] Dr Ruedemann has recently supplemented the data in our possession bearing on these sections by a careful review of those in Otsego and Schoharie counties considered here.

[3] The top of the Onondaga limestone is not clearly exposed in this section. Levels made from exposures ½ mile north of the railroad station indicate that this first outcrop of Marcellus shales does not lie more than 7 to 10 feet above that limestone.

	Feet	Inches
above base of section and about 40 feet above top of Onondaga. Here begins a series of limestones separated by shale beds and recurring with some differences in the character of the contained fauna. At the base of this lowest limestone, which has here a thickness of.....	1	5
occurs abundantly in a nodular layer the goniatite Anarcestes plebeiformis Hall, the only locality recorded for this interesting species, associated with Loxonema minuscula Hall, also known from no other locality. Agoniatites expansus does not occur in this layer, but is occasionally found in an imperfect condition with the rare variety, nodiferus (not elsewhere known) in the shale mass above which is.....	4	9
Then follows another limestone with Agoniatites and a few other fossils.....		8
Barren fissile shale.....		4
Limestone, top of falls.....		6
Shale with concretions.....	1	4
Gray nodular limestone with small Ambocoelia..	1	4
Dark limestone with ostracodes and Orthoceras separated from above by thin shale bed.....	7	2
From this point the section is covered for a distance of $\frac{1}{2}$ mile, representing an elevation of..	67	
Then follow black, typical Marcellus shales (on the Steenburg farm)	10	10
Dark gray limestone, barren in the lower layers with Agoniatites in the middle part and Orthoceras and ostracodes, etc. in the upper part...	7	6
	134	10

The amount of shale overlying these limestones is not shown in these sections. Holes dug for telephone poles along the road to Springfield show black shales at elevations of 40 to 60 feet above the highest outcrop already noted; and near the top of a hill to the east of a road just above the first highway crossing, 60 to 80 feet still higher, are dark gray, weathered, fissile, barren shales. These occurrences indicate at least 100 feet of shale above the recorded section. The repetition of Agoniatites expansus in beds separated by an interval of about 90 feet suggests the probability of a displacement along the covered interval of 67 feet. This point is not yet satisfactorily determined. Assuming its presence we find the Agoniatites fauna at something over 40 feet above the summit of the Onondaga.

If, however, no such displacement exists, the fauna with Agoniatites reappears after an absence from the sediments represented by a deposition of about 90 feet of shales and it thus rises to an elevation of 130 feet above the Onondaga limestone.

Schoharie county

Most of the Agoniatite limestone specimens from Schoharie county in the state collections were obtained by the late John Gebhard jr, probably from localities on the Lamoreaux farm, 1 mile southwest of Schoharie village, and the Burton farm 1 mile still farther south. At these places the limestone lies just below the surface and has been taken out for the construction of farm walls, but no exposure is afforded which defines the position of the beds in the rock section.

On Stony creek, east of Schoharie village, an outcrop of limestone is shown about 50 yards above the bridge near the confluence of the two branches. Here are about 20 inches of dark gray, impure limestone with Orthoceras marcellense and other fossils which usually accompany Agoniatites expansus, though that species has not been observed. For 16 feet above this the section is covered, then follows a continuous exposure of Marcellus shale for nearly a

mile, to Borst's sawmill, which is 180 feet above the limestone. The upper beds in this section, though retaining their dark blue-gray or blackish color, carry Spirifer and Chonetes and in this respect suggest correspondence with the upper beds in western sections which have latterly been regarded as pertaining to the Marcellus.

Typical Hamilton sandy shales are exposed just above Borst's mill. No limestone beds were observed in the section above the basal limestone. The distance of the latter above the Onondaga limestone is approximately estimated from levels, to be from 10 to 30 feet. The evidence in this section clearly indicates the rapid extinction of the Agoniatites limestone eastward from Otsego county and at points east of that here mentioned no outcrops of the horizon or evidence of its index fossils have been recorded.

FAUNA OF THE AGONIATITES LIMESTONE

Most of the species of this horizon have been made known by Conrad and Hall, and the limestone often retains its organic remains in fine preservation. Specially superior and well known are the great shells of Agoniatites expansus Vanuxem (=Gon. vanuxemi Hall). To this is to be added a large number (in view of the total faunal list) of other cephalopods. The fauna is peculiar in that it represents a deep water association introduced briefly in the shallower sea depositing the black shales, and its species are, further, to a notable percentage confined to it. Some of the outcrops of this layer in Onondaga county have of late years been carefully exploited by Prin. John D. Wilson of Syracuse, whose investigations have resulted in several additions to the faunal list, and to whom I am indebted for many favors in the study of the species.

Mesothyra ? (Manlius)
Proetus haldemani *Hall* (Cherry Valley)
Cyrtoceras alternatum *Hall* (Schoharie)
C. liratum *Conrad* (Manlius)
Gomphoceras conradi *Hall* (Schoharie, Manlius)
G. fischeri *Hall* (Manlius)

G. oviforme *Hall* (Schoharie, Manlius)
G. solidum *Hall* (Manlius)
G. transversum *Hall*
Nephriticeras bucinum *Hall* (Manlius)
Nautilus liratus *Hall* (Manlius)
Discites marcellensis *Vanuxem* (Manlius)
Parodiceras discoideum *Conrad* (Manlius, Schoharie)
Agoniatites expansus *Vanuxem* (Schoharie, Cherry Valley, Manlius, Union Springs, Flint creek, Stony Point, Lime Rock (in Onondaga limestone))
Thoracoceras wilsoni *sp. nov.* (Manlius)
Orthoceras aptum *Hall* (Manlius)
O. fustis *Hall* (Manlius)
O. marcellense *Vanuxem* (Manlius)
O. constrictum *Conrad* (Manlius)
Bactrites *sp.*?
Pleurotomaria rugulata *Hall*
Euomphalus planodiscus *Hall* (Manlius)
Loxonema delphicola *Hall* (Manlius)
Macrochilina onondagaensis *sp. nov.* (Manlius)
Chaenocardiola curta *Hall* (Manlius)
Panenka ventricosa *Hall* (Manlius)
Liorhynchus limitare *Hall* (Manlius)
Ambocoelia *cf.* nana *Grabau* (Cherry Valley)

Agoniatites expansus. This species, the diagnostic form of this horizon, is more generally diffused geographically than any of the others. At the west it occurs freely at Wood's quarry south of Union Springs, where the horizon lies close upon the Onondaga limestone. Still farther west, as this horizon approaches more and more nearly the Onondaga limestone, traces of it are less often seen, and west of the Flint creek section, Ontario county, the shell has been observed only at the base of the Marcellus section at Stony Point, Lake Erie. From outcrops of the Onondaga limestone in the neighborhood of Leroy we have a specimen, incomplete but doubtless representing a large individual of this species.

Thoracoceras wilsoni *sp. nov.* Pl. 8, fig. 1–5. The discovery of the species herewith presented is of more than ordinary interest, not alone from the fact that it constitutes a new element in this fauna, but also because of its very close relationship to a form described by Whiteaves from the zone with Stringocephalus burtini in the Devonic rocks of Manitoba.[1] The associates of this fossil in its occurrence at lakes Manitoba and Winnepegosis as reported by Dr Whiteaves are, besides Stringocephalus, some forms which pertain to the middle Devonic as developed in New York, such as Cyrtina hamiltonensis, Atrypa reticularis and var. aspera, Actinopteria boydi, Paracyclas elliptica, also Pentamerus comis Owen, which is not known to be a New York fossil, but pertains to the upper Devonic horizon in the state of Iowa, and a species identified as Rhynchonella pugnus Martin, a form already well known from the upper Devonic of New York, specially in the Chemung fauna at High point, Naples. So far as the peculiar generic characters of this species of Thoracoceras are concerned, they have not heretofore presented themselves in the cephalopod faunas of this state. Nor does the association of this species with the fossils of the Agoniatite limestone justify the construction of the fauna of the latter as in any way indicating the proper geologic horizon of Stringocephalus in the New York sediments.

The shell has a slight cyrtoceran curvature, notable chiefly in the distal or apertural region. The cast of the interior shows a very decided prismatic appearance, there being 10 well defined prism faces with flat or at times slightly concave surfaces. Of these faces that on the inner curvature of the dorsal surface is the broadest and is well defined over the body chamber, where the other faces become faint or quite extinguished. The body chamber shows a slight constriction at about one half its length. In two of the casts in which the body whorl and aperture are

[1] Descriptions of some new or previously unknown species of fossils from the Devonian rocks of Manitoba. Royal soc. Can. Trans. 1890. § 4, p. 93 (100-10) pl. 4-10 (7, fig. 1-4).

entirely preserved, this chamber has a length of 45 mm, which is equal to the depth of 6.5 chambers.

On the exterior the surface is ornamented by fine concentric or horizontal imbricating or engraved lines, which are bunched together into low concentric annuli and are crossed vertically by ridges of about the same size. These are 10 in number, to correspond with the prism angles. Where these cross the annuli, they are raised into projections which appear for the most part to be short, stout and blunt but in some vertical sections of the shell are apparently extended, acute and spiniform. These exterior markings become fainter on the body whorl, but are plainly visible to the aperture, in this respect contrasting to the condition of the internal surface. The aperture is sinuous with a marked channel on the left lateral margin.

Dimensions. The specimens observed have an apertural diameter of 30 to 40 mm and bear 16 septa in a distance of 100 mm from the last downward. The approximate entire length of these shells was 250 mm.

Locality. Manlius; John D. Wilson, collector and donor.

Macrochilina onondagaensis *sp. nov.* Shell rotund with short acuminate spire having incurved slopes, its length being about $\frac{1}{4}$ the entire length of the shell, or $_3$ that of the body whorl. Whorls largely concealed. Surface convex, sutures impressed; body whorl very high, somewhat abruptly convex near the suture where the surface of the penultimate whorl is overlapped for $\frac{4}{5}$ of its width. Non-umbilicate but with the columellar lip well defined and slightly twisted; aperture entire, outer lip but slightly thickened.

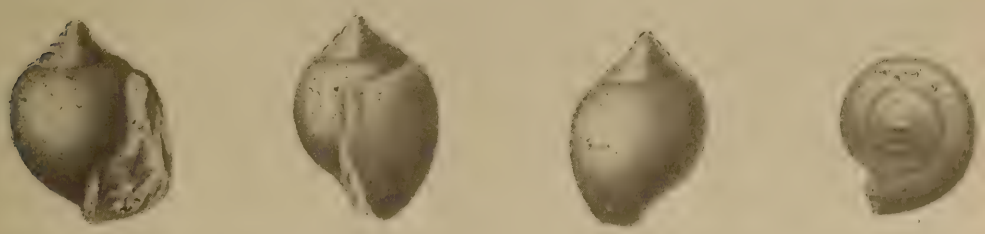

Fig. 1 Macrochilina onondagaensis natural size. Agoniatite limestone, Manlius N. Y.

Surface smooth, shining, bearing only fine concentric lines. Internal cast smooth.

Dimensions. Hight 22 mm; width across body whorl 17 mm; hight of body whorl 18 mm.

Locality. Agoniatite limestone, Manlius.

This very pretty species has been found by Prin. J. D. Wilson of Syracuse, who has considerately presented the type specimen to the state museum. It is unlike any species known from the New York Devonic in its short, concave spire and very large body whorl, features which will also distinguish it from other forms of the genus.

STRATIGRAPHY OF THE STAFFORD LIMESTONE

This limestone has highly characteristic lithologic structure. It is when fresh of a dark chocolate brown, compact in texture and inclined to be splintery under the hammer. Its fossils, in which it for the most part abounds, are often replaced by a black crystalline calcite, and, when weathered, blocks of the rock become gray, while the fossils are contrasted therewith by their dark tint. From the meridian of Flint creek westward to Lake Erie such blocks are common in the drift piles and are at once recognizable.

Along Flint creek is the first appearance of this interesting limestone, but it is seldom that complete sections of the beds are exposed anywhere in western New York. One was afforded by the Livonia salt shaft, and another, fully described at the conclusion of this paper, occurs at Lancaster, Erie co.

In the Livonia salt shaft, as recorded by D. D. Luther and the writer in the 13th report of the state geologist, the Marcellus strata were regarded as beginning at a depth of 650 feet from the surface and continuing downward to a depth of 866.5 feet, giving the beds a thickness of 216.5 feet. This apparently great thickness is due to the fact that, in the succession of the upper beds which pass gradually into the Hamilton shales above, a considerable part of the blue black shales was assigned to this formation on account of the preponderance of Marcellus species. This

portion of the section however simply serves to emphasize the gradual passage of the bituminous shale fauna into that of the calcareous shales and to establish the proper conception of the typical Marcellus fauna as that of these black shale beds and bands.

The Stafford limestone in this section lies at 823 feet, or 173 feet below the assumed top of the formation, the overlying strata being shales. It is here 2 feet thick, and is immediately underlain by 4 feet of black and bituminous shales with Liorhynchus, Panenka, Chonetes mucronatus, etc. the usual species of the typical shale beds. Thereunder follow 22 feet of black shales without fossils, this mass underlain by a thin shale bed with the usual species. From here are 13 feet to the top of the Onondaga limestone. Its position is thus about 50 feet above the Onondaga. The section is complete and brings out lucidly the thickening of the lower beds by calcification in their westward extent.

The Stafford limestone appears at various spots across the western district in the depression lying back and south of the Onondaga limestone escarpment. It is to be seen near Baggerly Corners, Ontario co. on the Phelps-Hopewell line road. At Littleville, 2 miles south of Avon, Genesee co. it appears in a gorge behind the mill with dark shales above and below. About a mile south of the station in Avon, in a brook east of the Erie railroad tracks, is another exposure, and the rock is again seen a short distance down the stream and beneath a mass of dark shale, another limestone outcrops, which appears to be the equivalent of the lower bed lying at 854 feet in the Livonia shaft, which we have suggested as marking the probable horizon of the Agoniatite limestone in this western region. Here it rests directly on the Onondaga limestone and stratigraphically is inseparable therefrom. The exposure of Stafford limestone at Stafford, Genesee co. lies about $\frac{1}{2}$ mile southeast of the station, where it has been quarried at various times. Such a large amount of the material lies exposed here that it makes an admirable spot for the collection of its fossils. At Leroy there is an

excellent exposure in the east bank of Oatka creek below the bridge at Main street.

At Lancaster, Erie co. the beds beneath the typical dark limestones at Stafford have become highly calcareous, giving a thickness of upward of 8 feet of the limestone section, all of these beds carrying a Hamilton fauna with some variations in character for the different beds. This section has been carefully studied by Elvira Wood, whose succinct account of the fauna and its variations is given at the close of this article. Here the beds, evidently continuous with the heavy limestones at Stafford, are the uppermost of the section (Miss Wood's vii and viii), and it is inferentially probable that at Stafford, which is only a few miles east of Lancaster, the lower part of this series is concealed; at the same time it is quite evident from the other sections cited that the calcifying of the lower beds is a feature of the western extension of this formation. Between Lancaster and Lake Erie, however, but a few incomplete outcrops of the horizon have been recorded.

FAUNA OF THE STAFFORD LIMESTONE

From the determinations made by the writer some years ago,[1] combined with those given by Miss Wood in the appended paper, we may ascribe the following to the fauna of the Stafford limestone.

1 Fauna of the Stafford limestone at Stafford, Livonia shaft, Flint creek, Lancaster (Miss Wood's upper beds vii and viii) and elsewhere

Fishes

Undetermined plates and scales

Worms

Spirorbis

Crustaceans

Homalonotus dekayi *Green*
Phacops rana *Green*
Cryphaeus boothi *Green*
C. boothi *var.* calliteles *Green*

[1] N. Y. state geol. 8th an. rep't p. 60, 1889.

Proëtus macrocephalus *Hall*
Cyphaspis craspedota *Hall & Clarke*
Primitiopsis punctulifera *Hall*

Cephalopods

Nautilus liratus *Hall*
N. *cf.* magister
Nephriticeras bucinum *Hall*
Orthoceras subulatum *Hall*
O. aegea *Hall*
O. marcellense *Vanuxem*
O. fenestrulatum *Clarke*
O. staffordense *Clarke*
O. eriense *Hall*

Pteropods

Tentaculites gracilistriatus *Hall*
Styliolina fissurella *Hall*

Gastropods

Platyceras attenuatum *Hall*
P. bucculentum *Hall*
Cyrtolites mitella *Hall*
Bellerophon lyra *Hall*
Diaphorostoma lineatum *Conrad*
Pleurotomaria lucina *Hall*
P. rugulata *Hall*
P. itys *Hall*
P. capillaria *Conrad*
P. sulcomarginata *Conrad*
Loxonema hamiltoniae *Hall*
Onychochilus nitidulus *Clarke*

Lamellibranchs

Pterinopecten exfoliatus *Hall*
Actinopteria muricata *Hall*
Liopteria laevis *Hall*
Cypricardinia indenta *Conrad*

Panenka mollis *var.* costata *Hall*
P. radians *Conrad*
Pterochaenia fragilis *Hall*

Brachiopods

Terebratula lincklaeni *Hall*
Cryptonella planirostris *Hall*
C. rectirostris *Hall*
Camarotoechia sappho *Hall*
C. horsfordi *Hall*
C. dotis *Hall*
C. prolifica *Hall*
C. pauciplicata *Wood*
Spirifer audaculus *Conrad*
S. fimbriatus *Conrad*
S. subumbona *Hall*
Ambocoelia nana *Grabau*
Meristella barrisi *Hall*
Trematospira gibbosa *Hall*
Strophalosia truncata *Hall*
Productella spinulicosta *Hall*
P. shumardiana *Hall*
Chonetes mucronatus *Hall*
C. scitulus *Hall*
C. lepidus *Hall*
Tropidoleptus carinatus *Conrad*
Stropheodonta inaequistriata *Conrad*
Leptostrophia perplana *Conrad*
Orthothetes chemungensis *Conrad*
O. arctostriatus *Hall*
Rhipidomella vanuxemi *Hall*
R. cyclas *Hall*
Crania crenistriata *Hall*
C. recta *Wood*
Craniella hamiltoniae *Hall*

Bryozoans

Hederella canadensis *Nicholson*
H. cirrhosa *Hall*
Reptaria stolonifera *Rolle*

Blastoids

Nucleocrinus lucina *Hall*

Corals

Favosites placenta *Hall*
Stereolasma rectum *Hall*
Striatopora limbata *Conrad*
Romingeria
Aulopora

2 Fauna of lower beds at Lancaster (Miss Wood's i-vi)

Worms

Spirorbis

Crustaceans

Cryphaeus boothi *Green*
Phacops rana *Green*
Cyphaspis craspedota *Hall*
Primitiopsis punctulifera *Hall*

Cephalopods

Orthoceras exile *Hall*
O. marcellense *Vanuxem*
Bactrites

Gastropods

Platyceras attenuatum *Hall*
Pleurotomaria capillaria *var.* rustica *Hall*
Onychochilus nitidulus *Clarke* (?)
Loxonema

Lamellibranchs

Pterinopecten exfoliatus *Hall*
Actinopteria muricata *Hall*
Cypricardinia indenta *Conrad*

Palaeoneilo
Panenka lincklaeni *Hall*
Leptodesma marcellense *Hall*

Brachiopods

Meristella barrisi *Hall*
M. meta *Hall*
Nucleospira concinna *Hall*
Spirifer mucronatus *Conrad*
S. fimbriatus *Conrad*
S. subumbona *Hall*
Tropidoleptus carinatus *Conrad*
Ambocoelia nana *Grabau*
Productella dumosa *Hall*
P. spinulicosta *Hall*
Strophalosia truncata *Hall*
Chonetes mucronatus *Hall*
C. scitulus *Hall*
Liorhynchus limitare *Hall*
Camarotoechia sappho *Hall*
C. prolifica? *Hall*
Schizobolus truncatus *Vanuxem*

Bryozoans

Hederella cirrhosa *Hall*
Trematopora tortalinea *Hall*

Pteropods

Tentaculites gracilistriatus *Hall*

Corals

Favosites placenta *Hall*
Ceratopora jacksoni *Grabau*
C. dichotoma *Grabau*

The fauna of the Stafford limestone is essentially an outburst of typical Hamilton species with a few survivors of earlier type, and invaded the state from the west, penetrating eastward as

far as Ontario county in a pure limestone sediment and perhaps as far as Cayuga county with a more argillaceous sediment, and was then driven back by the shallowing sea and the return of the bituminous muds. Its western origin determines the same derivation for the fauna of the great mass of calcareous and sandy Hamilton shales, which held the field for a long period over the full width of the state, but was eventually driven out of western New York by the invasion of a new western fauna, heralded by the early intrusion of the worldwide brachiopod, Hypothyris cuboides, and immediately followed by the outpouring of species constituting the fauna of the Manticoceras intumescens zone (Portage stage).

OTHER LIMESTONE BEDS IN THE MARCELLUS SHALES AND THEIR FAUNAS

A noteworthy limestone layer has been recorded in the Livonia shaft section lying 27 feet below the Stafford limestone, the interval being filled with black shales. This layer is 4 feet thick, the upper 2 feet being impure and almost devoid of fossils, the lower being a quite pure limestone containing the following species:

Phacops rana *Green*
Orthoceras subulatum *Hall*
O. incarceratum *Clarke*
O. lima *Hall*
Tornoceras uniangulare *Conrad*
Tentaculites gracilistriatus *Hall*
Pleurotomaria lucina *Hall*
Aviculopecten *cf.* fasciculatus *Hall*
Modiomorpha subalata
M. concentrica *Hall*
Cypricardinia indenta *Conrad*
Microdon bellistriatus *Conrad*
Nuculites oblongatus *Conrad*
Palaeoneilo plana *Conrad*
Tropidoleptus carinatus *Conrad*
Spirifer audaculus *Conrad*
Ambocoelia umbonata *Conrad*

A. praecumbona *Hall*
Athyris spiriferoides *Eaton*
Coelospira camilla *Hall*
Terebratula *sp.*
Stropheodonta inaequistriata *Conrad*
Leptostrophia perplana *Conrad*
Orthothetes pandora *Hall*
O. bellulus *Clarke*
Orthis *cf.* lenticularis *Hall*
Chonetes deflectus *Hall*
Chonetes *cf.* yandellanus *Hall*
Pholidops hamiltoniae *Hall*
Stictopora incisurata *Hall*
Stereolasma rectum *Hall*

Just below this lies a foot of impure limestone like that immediately above, composed largely of Tentaculites gracilistriatus with

Tornoceras uniangulare *Conrad*
Chonetes lineatus *Hall*
C. *cf.* deflectus *Hall*
Liorhynchus limitare *Hall*

From here downward for 6 feet are black shales with irregular concretions, underlain by 2 feet of hard, black calcareous shale with

Styliolina fissurella *Hall*
Liorhynchus limitare *Hall*
Panenka, *very large, cf.* P. lincklaeni *Hall*

A few inches below comes in normal Onondaga limestone. The fauna of this locally developed limestone bed carries certain surviving evidences of the Onondaga sea, in the species Coelospira camilla, Chonetes cf. yandellanus and Orthis cf. lenticularis; also in the Chonetes lineatus of the basal bed. The same horizon with more shaly sediment was exposed in the recent excavation at Stony Point, Lake Erie, referred to above, where, in addition to many of the

characteristic species (Orthothetes bellulus, Chonetes cf. yandellanus, Ambocoelia praeumbona) a single well defined example of Agoniatites expansus was obtained. It constitutes the first manifestation in New York state sections of the Hamilton fauna in its prenuncial invasion from the west, when it was complicated with the fauna already on the ground and failed to gain a lasting foothold or to develop favorably. The Agoniatites expansus occurring here may, in view of the other evidence, properly be regarded, like the species last mentioned, as a survivor of the Onondaga fauna.

CONCLUSION

The Agoniatite limestone fauna was an invader from the west, dating from the closing phase of the Onondaga limestone. Directly in its train followed the prenuncial cohorts of the Hamilton fauna. The former held the footing it had gained while the latter yielded to unfavorable conditions and temporarily retired from the field.

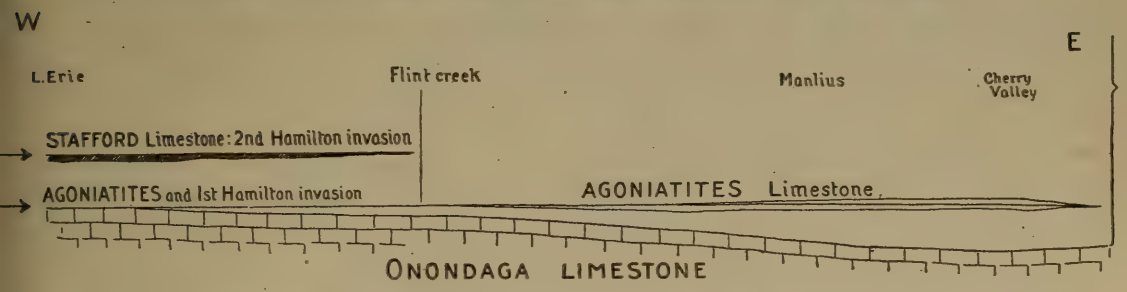

Fig. 2 Diagrammatic representation of the relation of the Hamilton faunal invasions to the sediments of Onondaga and Marcellus time.

The facts recorded above indicate quite clearly the descent of the Agoniatite horizon westward from an elevation of fully 50 feet above the summit of the Onondaga limestone to and probably into that limestone itself, a condition which stratigraphy interprets as a replacement in central and eastern New York sections, of the upper layers of the latter by the lower beds of the Marcellus shales or, conversely, the occupancy of the field in western New York by the Onondaga sea after Marcellus deposition had for some time been under way in central and eastern New York. The fauna attained its highest development in Onondaga and eastward counties where it reached a secluded

part of the interior sea most favorable for its increase. Here it is followed and preceded by a quite distinct association involved in bituminous muds, and it is therefore natural that a few of the Marcellus species have strayed into the Agoniatite fauna. The tendency to lime deposition recurred during Marcellus time after the sea had shallowed in western New York, but ere that event the Agoniatite derivative of the Onondaga fauna had migrated eastward and disappeared.

The fauna of the Stafford limestone was also an invader of later date from the west and the second appearance of the Hamilton fauna within the confines of this state.

The composition of the species list is final in determining the affiliation of the Stafford fauna. This invasion, too, was unsuccessful, reaching no farther eastward than the eastern part of Ontario county. Had the fauna dispersed more widely and been able to take and keep possession of the ground which it subsequently acquired, Hamilton time and sedimentation would have been a more important element in the New York succession.

MARCELLUS (STAFFORD) LIMESTONES OF LANCASTER, ERIE CO. N. Y.

(Communicated for the report of the state paleontologist)

BY ELVIRA WOOD

Pl. 9

INTRODUCTION

The existence of a bed of limestone within the Marcellus formation of western New York was early recorded by Prof. James Hall[1]; and to this limestone John M. Clarke[2] has given the name Stafford limestone, because of its exceptional development at Stafford, Genesee co.

Prof. I. P. Bishop[3] describes the occurrence of limestone beds at Lancaster, Erie county which he correlates with the Stafford limestone of Clarke, but with a mention of only one fossil, an Orthoceras, in the upper beds. No account of the fossils of this locality has been published, and it is with the fauna and its characteristics that the following paper is chiefly concerned.

SUCCESSION OF THE MARCELLUS BEDS AT LANCASTER

The Marcellus limestones of Lancaster N. Y. are best exposed in the bed of Plumbottom creek above its junction with Cayuga creek. The general direction of these streams is shown in the accompanying map of a part of the town of Lancaster.

The dark gray Marcellus shales are first seen in the bed of Plumbottom creek about half way between Foundry and Court streets. Ascending the stream toward the east the bed rock changes in character to a compact limestone lighter in color than the shale, and highly fossiliferous. The limestone is separable into beds varying in lithologic character and in fossil contents, and is well exposed in the bed and banks of the creek to the dam above Court street, and in the quarry of George

[1] Geol. N. Y. 4th geol. district 1843. p. 177-83.

[2] List of the species constituting the known fauna and flora of the Marcellus epoch in New York. N. Y. state geol. 8th an. rep't. 1888. p. 60.

[3] Structural and economic geology of Erie county. N. Y. state geol. 15th an. rep't. 1898. 1:305.

Bingham above the dam. In this quarry may also be seen the contact between the limestone and the dark Marcellus shale and shaly limestones which form the bed rock beneath the surface soil of the region.

DETAILED DESCRIPTION OF THE SECTION AT PLUMBOTTOM CREEK

The general relation of the limestone beds to those of the Marcellus shale is shown in the following table, where the typical Marcellus layers are lettered, and the limestones numbered, from below upward. The limestone beds have been carefully measured and these measurements have been previously recorded by Bishop[1].

SECTION EXPOSED AT PLUMBOTTOM CREEK

		Inches	Feet	Inches
Shaly limestone	H	18		
Shaly limestone	G	5		
Shale	F	18		
			3	5
Limestone	VIII	12		
	VII	14		
	VI	14		
	V	18		
	IV	10		
	III	14		
	II	6		
	I	12		
			8	4
Lower shale	E	12		
	D	12		
	C	6		
	B	4		
	A	4		
			3	2
			14	11

[1] Structural and economic geology of Erie county. N. Y. state geol. 15th an. rep't. 1898. 1:305.

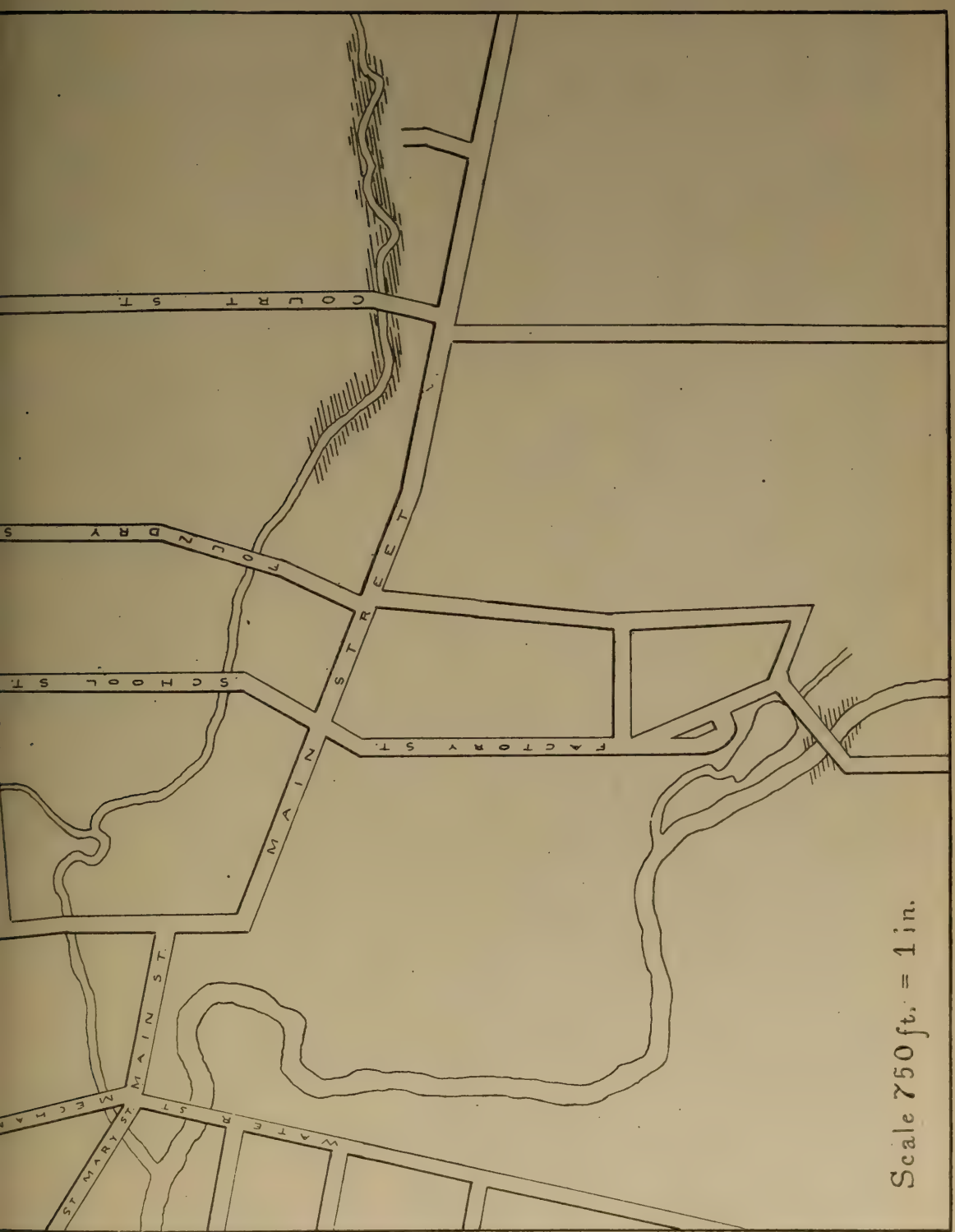

FIG. 1 Sketch map of Plumbottom creek, Lancaster N. Y.

Lower Marcellus shale

A 4 inches. This is the lowest layer of the Marcellus shales exposed in the section. The rock is a gray calcareous shale breaking irregularly, and characterized by the great abundance of ostracodes, certain layers being thickly covered with them. Styliolina fissurella occurs frequently among the ostracodes, but other fossils are comparatively rare. The following species were found in this bed:

Chonetes mucronatus *Hall*	r[1]
Strophalosia truncata (*Hall*)	r
Liorhynchus limitare (*Vanuxem*)	rr
Ambocoelia praeumbona *Hall*	rr
Nuculites nyssa *Hall*	c
Lunulicardium fragile *Hall*	c
Modiomorpha subalata (*Conrad*)	r
Styliolina fissurella (*Hall*)	c
Orthoceras subulatum *Hall*	rr
Isochilina (?) fabacea *Jones*	cc
Primitiopsis punctulifera (*Hall*)	r

B 4 inches. This bed is a gray extremely fissile shale slightly darker in color than bed A. Fossils are abundant, Chonetes mucronatus, Strophalosia truncata, and Lunulicardium fragile being the most common forms, and all about equally numerous. The complete list is as follows:

Chonetes mucronatus *Hall*	cc
Strophalosia truncata (*Hall*)	cc
Liorhynchus limitare (*Vanuxem*)	rr
Tropidoleptus carinatus *Conrad*	rr
Ambocoelia nana *Grabau*	r
Nuculites triqueter *Conrad*	r
Lunulicardium fragile *Hall*	cc
Modiomorpha subalata (*Conrad*)	rr
Styliolina fissurella (*Hall*)	cc
Orthoceras subulatum *Hall*	rr
Goniatites ?	rr
Isochilina (?) fabacea *Jones*	rr

[1] c, common; cc, very common; r, rare; rr, very rare.

C 6 inches. The top of this bed is about 2 feet below the lowest limestone layer. It is a calcareous shale much less fissile than bed B. The rock recalls bed A in general appearance, but is considerably darker and is highly fossiliferous. Nuculites triqueter is the most common fossil.

The following species were found here.

Reptaria stolonifera *Rolle*	rr
Chonetes mucronatus *Hall*	c
Strophalosia truncata (*Hall*)	rr
Liorhynchus limitare (*Vanuxem*)	r
Ambocoelia nana *Grabau*	r
Nuculites nyssa *Hall*	r
N. triqueter *Conrad*	cc
Leptodesma marcellense *Hall*	rr
Lunulicardium fragile *Hall*	c
L. curtum *Hall*	r
Aviculopecten exacutus *Hall*	rr
Modiomorpha subalata (*Conrad*)	r
Pleurotomaria rugulata (?) *Hall*	rr
Styliolina fissurella (*Hall*)	r
Orthoceras subulatum *Hall*	c
Goniatites vanuxemi (?) *Hall*	c
Isochilina (?) fabacea *Jones*	r

D 12 inches. The lower part of bed D is similar to the preceding, but is more fissile and contains Liorhynchus limitare (a rare form in bed C) as the most abundant fossil. The fissility becomes more pronounced till, in the upper part of the bed, the rock breaks into extremely thin laminae with their surfaces crowded with the flattened shells of Liorhynchus limitare and scattered individuals of Strophalosia truncata. In certain of these upper layers the latter condition becomes reversed and the Strophalosia is the more abundant form, the shells overlapping one another. The individuals of both species are here exceptionally large. This layer is not well exposed in the bed of Plumbottom creek but may be seen in situ in places along the bank.

The same layer occurs in the bed of Cayuga creek below the upper carriage bridge, about half a mile southwest from the outcrop in Plumbottom creek. Large slabs of this rock are found on the banks of the stream just below the upper bridge and have been apparently lifted out by frost and ice action, but belong below the exposed limestone which here forms a small fall with a pool 4 or 5 feet deep at its base. The lowest layer of limestone evidently corresponds to bed I (see below). Above this are two layers of limestone, the lower 11 and the upper 7 inches thick and still farther up the stream is a bed which corresponds to bed V of the Plumbottom creek section.

The fossils from the lowest bed, Cayuga creek, are of the same species as those of the following list from Plumbottom creek, with the addition of Panenka lincklaeni.

Chonetes mucronatus *Hall*	r
Strophalosia truncata (*Hall*)	cc
Liorhynchus limitare (*Vanuxem*)	cc
Tropidoleptus carinatus (*Conrad*)	r
Ambocoelia nana *Grabau*	cc
Nuculites nyssa *Hall*	rr
N. triqueter *Conrad*	r
Lunulicardium fragile *Hall*	r
Aviculopecten exacutus *Hall*	rr
Styliolina fissurella (*Hall*)	cc
Orthoceras subulatum *Hall*	rr
Goniatites ?	rr
Isochilina (?) fabacea *Jones*	rr

E 12 inches. The bed which immediately underlies the limestones is a gray calcareous shale abounding in Orthoceras subulatum and Chonetes scitulus. At certain levels of the rock are apparently current accumulations of crowded and broken shells of Lunulicardium fragile. The rock splits irregularly into thin layers.

The fossils found in the bed are as follows:

Chonetes scitulus *Hall*	cc
Ambocoelia nana *Grabau*	rr
Orthonota (?) parvula *Hall*	rr
Nuculites triqueter *Conrad*	rr
Panenka lincklaeni *Hall*	rr
Lunulicardium fragile *Hall*	cc
Styliolina fissurella (*Hall*)	cc
Orthoceras subulatum *Hall*	cc
Cryphaeus boothi *Green*	rr
Primitiopsis punctulifera (*Hall*)	c
Isochilina (?) fabacea *Jones*	c

Marcellus (Stafford) limestone

I 12 inches. The lowest bed of the limestone series presents a striking contrast both in lithologic character and in its fauna to the shale which underlies it. This bed has an irregularly hummocky surface of concretionary origin, though it is practically a continuous mass. The rock is compact, dark gray in color, with no tendency toward shaly structure. It is soft and apparently contains little silicious matter.

The whole bed is largely made up of shells of Strophalosia truncata and Ambocoelia nana, the extreme irregularity of fracture being due to the innumerable fragments of these shells, whose black, shining surfaces give the rock a very dark appearance. As might be expected, in the limestone the individuals are not at all flattened, but they are usually of small size, for each species.

As noted above, this bed also occurs in Cayuga creek, where it forms a fall beneath the upper carriage bridge, and it is exposed in the bed of the stream. It is 12 inches thick and the character of the rock is indistinguishable from that of the same bed at Plumbottom creek. The fossils are of the same species.

In an excavation for a sewer near the corner of Buffum and Seneca streets, in southeastern Buffalo, material from this bed

was brought to the surface, and shows in addition to the fossils mentioned below well preserved specimens of Panenka lineklaeni. For material from this locality I am indebted to Miss I. C. Strickler of Buffalo.

Still another outcrop of this bed has been observed on the left bank of Ellicott creek near Wende station. Orthoceras exile is a common fossil at this place.

The species identified from this bed at Lancaster are:

Chonetes mucronatus *Hall*	cc
Strophalosia truncata (*Hall*)	cc
Liorhynchus limitare (*Vanuxem*)	c
Ambocoelia nana *Grabau*	cc
Meristella meta *Hall*	rr
Orthoceras exile *Hall*	rr

II 6 inches. This bed is made up of large concretions which are confluent or separated by small masses of calcareous shale only. The limestone of which the concretions are composed is similar to that of bed I, but is finer grained and breaks with a conchoidal fracture. Fossils are less numerous than in bed I, there being fewer individuals but many more species. Strophalosia truncata and Ambocoelia nana are slightly larger than the same species in the underlying bed. The list of fossils is as follows:

Chonetes mucronatus *Hall*	c
C. scitulus *Hall*	rr
Strophalosia truncata (*Hall*)	cc
Productella dumosa *Hall*	r
Liorhynchus limitare (*Vanuxem*)	cc
Ambocoelia nana *Grabau*	cc
Spirifer (Martinia) subumbona *Hall*	rr
Palaeoneilo *sp.*	rr
Leptodesma marcellense *Hall*	c
Pleurotomaria itys *Hall*	r
P. capillaria *var.* rustica *Conrad*	r
Onychochilus (?) nitidulus *Clarke*	rr

Loxonema *sp.*	rr
Coleolus tenuicinctus (?) *Hall*	rr
Orthoceras exile *Hall*	r
O. marcellense *Vanuxem*	r
Phacops rana (*Green*)	rr
Primitiopsis punctulifera *Hall*	r

III 14 inches. This bed is a mass of confluent concretions whose surfaces often show cracks filled with consolidated mud. The concretions are of compact, rather light gray limestone, which is harder and breaks more irregularly than that of bed II. Irregular masses of crystallized calcite, probably filling cavities left by dissolved shells, are common, and there are also small masses of sphalerite and chalcopyrite. Fossils are abundant, well preserved, and indicate fairly robust individuals of each species.

The following fossils were found in this bed:

Schizobolus concentricus (*Vanuxem*)	rr
Chonetes mucronatus *Hall*	c
C. scitulus *Hall*	rr
Strophalosia truncata (*Hall*)	r
Liorhynchus limitare (*Vanuxem*)	c
Spirifer (Martinia) subumbona *Hall*	rr
Ambocoelia nana *Grabau*	r
Nucleospira concinna *Hall*	rr
Meristella barrisi *Hall*	rr
Leptodesma marcellense *Hall*	rr
Pleurotomaria itys *Hall*	rr
Onychochilus (?) nitidulus (?) *Clarke*	r
Loxonema *sp.*	r
Coleolus tenuicinctus (?) *Hall*	c
Orthoceras exile *Hall*	c
Phacops rana (*Green*)	c
Primitiopsis punctulifera *Hall*	rr

IV 10 inches. The character of this bed is similar to that of the preceding except that the large flattened concretions which

form the main portion of the mass are of a darker and somewhat harder limestone than that of bed III. Spirifer (Martinia) subumbona, Ambocoelia nana and Strophalosia truncata of large size are common fossils. Ceratopora jacksoni is also common, the long corallites standing out in relief on the weathered surface.

The list of species found is as follows:

Ceratopora jacksoni *Grabau*	cc
Spirorbis *sp.*	r
Hederella cirrhosa *Hall*	rr
Craniella hamiltoniae (*Hall*)	rr
Chonetes mucronatus *Hall*	cc
Strophalosia truncata (*Hall*)	cc
Productella dumosa *Hall*	rr
Camarotoechia prolifica (?) (*Hall*)	c
Liorhynchus limitare (*Vanuxem*)	c
Spirifer (Martinia) subumbona *Hall*	cc
Ambocoelia nana *Grabau*	cc
Cypricardinia indenta (*Conrad*)	r
Pleurotomaria *sp.*	rr
Phacops rana (*Green*)	r

V 18 inches. The proportion of shale at this level is considerably increased. The whole bed is soft and decomposes readily under the action of the weather.

This layer occurs again in the bed of Cayuga creek, where it forms the upper of the limestone layers mentioned above. There the lowest of the limestone layers corresponds with bed I, while this, as indicated by the abundance of Chonetes scitulus in both beds, may be correlated with bed V. At least two intervening beds could be recognized. The lithologic character of the 11 inch bed and the few fossils obtained are in correspondence with bed II at Plumbottom creek and there is a similar correspondence between the 7 inch bed and bed IV, but the small amount of material obtained does not justify a definite correlation. The intervening limestone could not be

accurately measured, and the entire thickness is probably greater than 18 inches, since this corresponds to 30 inches of the Plumbottom creek section, and the beds I and V at Cayuga creek have suffered little if any diminution in thickness. Bed V may be seen below the electric car bridge and just at the foot of the dam which rests on it. At this place the entire thickness of the bed is exposed. It seems to be made up of two layers of concretions embedded in shale, the lower 12, and the upper 6 inches in thickness. The middle part is compact and fossiliferous, the upper and lower parts more shaly and with fewer fossils. Chonetes scitulus is the most common fossil, while Ceratopora jacksoni and C. dichotoma are fairly abundant.

Fragments from a bed similar to this were obtained from the locality previously mentioned, near the corner of Buffum and Seneca streets, Buffalo. They contain Chonetes mucronatus, C. scitulus, Strophalosia truncata, Spirifer mucronatus and Cyphaspis craspedota.

The following list offers a means of comparing fossils from bed V, Plumbottom creek, with those from Cayuga creek.

Plumbottom creek

Crinoid stems	rr
Chonetes mucronatus *Hall*	rr
C. scitulus *Hall*	cc
Strophalosia truncata (*Hall*)	r
Camarotoechia prolifica (?) *Hall*	c
Liorhynchus limitare (*Vanuxem*)	rr
Tropidoleptus carinatus (*Conrad*)	r
Spirifer (Martinia) subumbona (*Hall*)	c
S. mucronatus *Conrad*	r
Ambocoelia nana *Grabau*	c
Leptodesma marcellense *Hall*	rr
Phacops rana (*Green*)	rr
Cryphaeus boothi *Green*	c

Cayuga creek

Fistulipora *sp.*	rr
Stictopora *sp.*	rr
Ceratopora jacksoni *Grabau*	cc
C. dichotoma *Grabau*	c
Crinoid stems	c
Chonetes mucronatus *Hall*	r
C. scitulus *Hall*	cc
Atrypa spinosa *Hall*	rr
Liorhynchus limitare (*Vanuxem*)	rr
Spirifer mucronatus *Conrad*	r
Ambocoelia nana *Grabau*	rr
Phacops rana (*Green*)	r

VI 14 inches. Farther up, near the dam, another layer of impure concretionary limestone is exposed in the bed of the stream. The rock breaks irregularly into relatively thin layers. Cypricardinia indenta is the most common fossil.

The complete list is as follows:

Favosites placenta *Rominger*	c
Crinoid stems	c
Trematopora (Orthopora) tortalinea *Hall*	r
Chonetes mucronatus *Hall*	r
C. scitulus *Hall*	c
Productella spinulicosta *Hall*	r
Camarotoechia sappho *Hall*	r
Liorhynchus limitare (*Vanuxem*)	r
Spirifer mucronatus *Conrad*	rr
S. (Reticularia) fimbriatus (*Conrad*)	rr
Actinopteria muricata *Hall*	rr
Pterinopecten exfoliatus *Hall*	rr
Cypricardinia indenta *Conrad*	cc
Platyceras (Orthonychia) attenuatum *Hall*	rr
Tentaculites gracilistriatus *Hall*	rr
Phacops rana (*Green*)	r
Cryphaeus boothi *Green*	rr

VII 14 inches. Near the foot of the dam, and just at the bend of the stream, a 14 inch layer of compact semicrystalline limestone is exposed, and above the dam in the quarry the same bed may again be seen. This limestone contains considerable pyrite in minute grains, and also small segregations of flint. It is fine grained, and breaks with a conchoidal fracture. The rock is quarried, the quarrying having proceeded in the fall of 1899 to a depth of 9 inches in the underlying bed, VI. This is the most interesting bed of the section, being rich in large and well preserved fossils of many species. Meristella barrisi is the most abundant fossil, and large Orthocerata are fairly common. The following species were identified.

Stereolasma rectum (*Hall*)	rr
Crinoid stems	r
Spirorbis *sp.*	c
Hederella canadensis (*Nicholson*)	rr
H. cirrhosa (*Hall*)	r
Reptaria stolonifera *Rolle*	r
Crania crenistriata *Hall*	rr
C. recta *sp. nov.*	r
Craniella hamiltoniae (*Hall*)	c
Stropheodonta (Leptostrophia) perplana (*Conrad*)	rr
S. inequistriata (*Conrad*)	cc
Orthothetes chemungensis arctostriata *Hall*	rr
Chonetes mucronatus *Hall*	cc
C. lepidus *Hall*	rr
Productella spinulicosta *Hall*	cc
Rhipidomella vanuxemi *Hall*	r
Camarotoechia horsfordi *Hall*	rr
C. sappho *Hall*	cc
C. pauciplicata *sp. nov.*	rr
Cryptonella rectirostris *Hall*	r
C. planirostris *Hall*	rr
Spirifer (Martinia) subumbona *Hall*	r
S. (Reticularia) fimbriatus (*Conrad*)	c

Ambocoelia nana *Grabau*	r
Trematospira gibbosa *Hall*	r
Meristella barrisi *Hall*	cc
Lunulicardium fragile *Hall*	rr
Actinopteria muricata *Hall*	rr
Pterinopecten exfoliatus *Hall*	r
Pleurotomaria lucina *Hall*	rr
Styliolina fissurella (*Hall*)	c
Orthoceras marcellense *Vanuxem*	c
O. eriense *Hall*	rr
O. aegea *Hall*	rr
Nephriticeras bucinum (*Hall*)	rr
Phacops rana (*Green*)	c
Cryphaeus boothi *Green*	rr
Cyphaspis craspedota *Hall & Clarke*	rr

VIII 12 inches. Near the eastern end of the quarry is exposed another bed of limestone essentially like the last lithologically and containing similar fossils but with fewer individuals. This bed constitutes the upper member of the limestone series, and from its light gray color, compact texture, and its many species of large fossils, it is strongly contrasted with the dark Marcellus shale which overlies it.

The fossils found in this bed are as follows:

Favosites placenta *Rominger*	rr
Stereolasma rectum (*Hall*)	rr
Crinoid stems	r
Spirorbis *sp.*	c
Craniella hamiltoniae (*Hall*)	c
Stropheodonta (Leptostrophia) perplana (*Conrad*)	rr
Orthothetes chemungensis arctostriata *Hall*	rr
Chonetes mucronatus *Hall*	c
Rhipidomella vanuxemi *Hall*	rr
Camarotoechia sappho *Hall*	c
Cryptonella planirostris *Hall*	rr
Ambocoelia nana *Grabau*	rr

Trematospira gibbosa *Hall*	rr
Meristella barrisi *Hall*	cc
Panenka mollis *Hall*	rr
Cypricardinia indenta (*Conrad*)	rr
Styliolina fissurella (*Hall*)	c
Tentaculites gracilistriatus (*Hall*)	rr
Orthoceras marcellense *Vanuxem*	c
O. fenestrulatum *Clarke*	rr
Phacops rana (*Green*)	r
Primitiopsis punctulifera (*Hall*)	r

Marcellus shale

F 18 inches. Overlying the upper limestone bed is a fissile gray shale, some parts of which are heavy bedded. It contains Ambocoelia umbonata and Styliolina fissurella in great abundance, the former standing out in relief on the weathered surfaces. Species identified are:

Ceratopora dichotoma *Grabau*	r
Chonetes lepidus *Hall*	c
Liorhynchus limitare (*Vanuxem*)	r
Atrypa reticularis (*Linné*)	c
Ambocoelia umbonata (*Conrad*)	cc
Meristella barrisi *Hall*	rr
Lunulicardium fragile *Hall*	r
Styliolina fissurella (*Hall*)	cc
Orthoceras aegea *Hall*	c
Phacops rana (*Green*)	cc

G 5 inches. Bed F is followed by a dark gray earthy and somewhat shaly limestone with few fossils except Styliolina fissurella which is abundant. The following were found:

Ceratopora dichotoma *Grabau*	r
Liorhynchus limitare (*Vanuxem*)	c
Styliolina fissurella (*Hall*)	cc

H 18 inches. The upper exposed bed which forms the substratum beneath the soil, is a shaly dark bluish gray limestone.

The only fossils observed were a few fragments, probably plant remains, Liorhynchus limitare and Lunulicardium fragile.

Other exposures of the upper Marcellus shales have been noted on the banks of Cayuga creek. At Lake Como, above the level of the dam, is a 5 foot layer of gray calcareous shale containing Liorhynchus limitare as its most common fossil, and, farther up the creek, at Van Duzee's farm, a 4 foot layer of similar shale is exposed in the bed of the stream. It contains Liorhynchus limitare, Strophalosia truncata, Chonetes lepidus, etc. It thus appears that at this locality also the fauna of the upper shales is typically Marcellus in character and strongly contrasted with that of the limestones below.

REVIEW OF THE FAUNA

ANTHOZOA

STEREOLASMA Simpson

Stereolasma rectum (Hall)

Simpson. N. Y. state mus. Bul. 39, p. 205

Two specimens only of this species were found. The individuals are small and both represent the lower part of the coral. They are well preserved, showing the septa and numerous dissepiments. One specimen measures 13 mm in length, and 9 mm in diameter.

FAVOSITES Lamarck

Favosites placenta Rominger

Geol. sur. Mich. 3: 34, pl. 2

This coral occurs as thin, irregularly undulating expansions in beds VI and VIII. The polished section shows the corallites to be sometimes of equal size but more commonly large and somewhat rounded individuals are surrounded by others which are smaller and more angular.

AULOPORA Goldfuss

Aulopora *sp.*

A loosely branching corallum, probably of this genus, was found attached to Orthoceras eriense. The upper half is broken away showing only a longitudinal section. Budding takes place from the upper part of the corallites, and usually from one side only, but at about every fourth or fifth individual a bud is produced on both sides, thus giving rise to the loose branching, characteristic of the species. This form resembles Aulopora subtenuis of the Helderbergian, but, on account of the imperfect preservation of the fossil, no specific determination has been made.

CERATOPORA Grabau

Ceratopora jacksoni Grabau, pl. 1, fig. 1

Bost. soc. nat. hist. Proc. 28:415, pl. 1, 2

Long branching individuals of this species are very common in bed IV, and they occur also at Cayuga creek. Very perfect specimens are found on the weathered surfaces, and fragments from 1 to 2 inches long may be easily detached from the rock.

Ceratopora dichotoma Grabau

Bost. soc. nat. hist. Proc. 28:418, pl. 2, 3, 4

Only fragments comprising two or three corallites were found. They occur in bed V, Cayuga creek, and in the upper Marcellus shale, bed F, at Plumbottom creek.

CRINOIDEA

Crinoid stems are of frequent occurrence in the upper four of the limestone beds, but no other remains of crinoids have been observed.

ANNELIDA

SPIRORBIS Lamarck

Spirorbis *sp.*

Specimens showing the transverse section only are common in beds VII and VIII, and they are found also in bed IV. They are attached to Orthoceras marcellense and O. eriense.

BRYOZOA

HEDERELLA Hall

Hederella canadensis (Nicholson)

Pal. N. Y. 6:277, pl. 65

A single zoarium, 7 mm long, was found in bed VII. It is attached to a fragment of Orthoceras, prabably O. marcellense.

Hederella cirrhosa Hall

Pal. N. Y. 6:277, pl. 65, fig. 12, 13

Found on the surface of Nephriticeras bucinum, branching loosely over an area of about 1 square inch.

REPTARIA Rolle

Reptaria stolonifera Rolle

Pal. N. Y. 6:274, pl. 65

A large zoarium branching profusely over the surface of an Orthoceras eriense was found in bed VII. Only small fragments were found in bed III.

FISTULIPORA McCoy

Fistulipora? *sp.*

On the surface of bed V were found Bryozoa, probably of this genus, showing the circular shell apertures and the mesopores. It resembles Fistulipora? unilinea, but the specimen is too imperfect to be fully identified.

TREMATOPORA Hall

Trematopora (Orthopora) tortalinea Hall

Pal. N. Y. 6:180, pl. 56, fig. 9

Small fragments of this species were found on the weathered surfaces of bed VI.

STICTOPORA Hall

Stictopora *sp.*

Fragments of a zoarium referable to this genus were found on the weathered surfaces of bed V. The longitudinal rows of cell apertures with intervening ridges, and the mode of branching are shown, but the specimen is too poorly preserved to be identified with certainty.

BRACHIOPODA

SCHIZOBOLUS Ulrich

Schizobolus truncatus (Hall)

Pal. N. Y. 4:23, pl. 1, 2

This species is represented by one shell from bed III. It is a fairly well preserved interior of a brachial valve with median septum and muscular scars. The lowest horizons at which this species has been previously recorded is the upper Hamilton (Moscow) shales. Its occurrence at this lower level is of interest.

CRANIA Retzius

Crania crenistriata Hall

Pal. N. Y. 4:28, pl. 3

One specimen has been found in bed VII, attached to Orthoceras marcellense.

Crania recta[1] *sp. nov.*

Pl. 9, fig. 1-3

The three specimens obtained are all upper valves. Two are molds of the external surface with minute fragments of the posterior portion of the shell retained; the third shows the exterior. The former were attached to the interior and the latter to the exterior of the living chamber of Orthoceras.

Upper valve transverse, having the form of a flattened rim with sharply elevated central portion; beak subcentral. A shallow sinus, widening toward the front, extends from the beak to the anterior margin. Outline of the valve straight on the posterior side, regularly rounded at the sides, and slightly arcuate in front. Surface marked by fine lines of growth. Under a strong magnifier the surface is seen to be minutely granulose, a feature not visible under an ordinary hand lens. Posterior adductor scars are shown on a fragment of shell remaining.

Lower valve unknown.

The characteristic features of the species are the straight posterior margin and greater transverse diameter.

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[1] Acknowledgments are due to Charles Schuchert, for comparing these shells with other species of the genus.

Measurements of three specimens are: 1) anteroposterior 5 mm, lateral 7.8 mm; 2) anteroposterior 5 mm, lateral 6 mm; 3) anteroposterior 4 mm, lateral 5.2 mm, depth 1 mm.

CRANIELLA Oehlert

Craniella hamiltoniae (Hall)

Pal. N. Y. 4:27, pl. 3

This species is fairly common in beds VII and VIII. All the shells found are attached to Orthoceras, and are of the normal adult proportions.

STROPHEODONTA Hall

Stropheodonta (Leptostrophia) perplana Conrad

Pal. N. Y. 4:98, pl. 11, 12, 17, 19

Fragments of several individuals have been found in bed VII, and one nearly complete pedicle valve in bed VIII has a length of 19 mm and width of 25 mm.

Stropheodonta inequistriata (Conrad)

Pal. N. Y. 4:93, pl. 12

Pedicle valves of this species are fairly common in bed VII. The largest specimen found has a length of 14.5 mm and width of 21 mm. The surface markings are more delicate than those of the average specimen from the Hamilton shales, but are otherwise similar.

ORTHOTHETES Fischer de Waldheim

Orthothetes chemungensis arctostriata Hall

Pal. N. Y. 4:71, pl. 9

The specimens are much broken, but all show the characteristic sharply elevated costae and fine concentric striae. One fairly perfect mold of a pedicle valve is of the normal form and size.

CHONETES Fischer de Waldheim

Chonetes mucronatus Hall

Pal. N. Y. 4:124, pl. 20, 21

This species is common in all of the lower shales except the upper fissile part of bed D and bed E, where it has not been

observed. It becomes extremely abundant in bed I of the limestone series and is common in all the other limestone beds, but has not been found in beds F, G, and H, of the overlying shales. The specimens in the lower shales are small but are characterized by the great length of the cardinal spines (fig. 4). Individuals having exceptionally long spines are not only smaller but usually have also fewer plications. A specimen of average proportions in bed C is 5.4 mm long, 6.8 mm wide, and bears 22 plications. In bed I the majority of the shells are smaller than in the shales, but in beds II and III there is a perceptible increase in the average size of the specimens. The largest shell which could be referred to this species occurs in bed VI. It is 9 mm long, 10.4 mm wide, and has 20 plications. The single cardinal spine which is retained is nearly parallel with the hinge line.

Chonetes lepidus Hall

Pal. N. Y. 4:132, pl. 21

This is a rare species in the limestones, only two well preserved specimens having been found in bed VIII, but it becomes abundant in the shales immediately overlying the limestone. The plications on specimens from this locality are slightly less prominent than on those from the Hamilton shales.

Chonetes scitulus Hall

Pl. 9, fig. 4-6

Pal. N. Y. 4:130, pl. 21

In bed III a single well preserved individual of this species was found, but it is common in beds IV and V.

Associated with shells of the normal form and size are others which have been referred with doubt to this species. The shells are slightly transverse, the largest specimens somewhat less so than the smaller, and the hinge line equals the greatest width of the shell. The ventral valve is moderately convex with often a faint sinus along the median line which is traceable about two thirds the length of the shell, but disappears before reaching the margin. The dorsal valve has a concavity less than the con-

vexity of the opposite valve. The interior is not well shown. The surface bears fine rounded or subangular plications, which increase by bifurcation and intercalation till there are 11 or 12 in the space of 3 mm on the margin of the shell. Frequently two of these are stronger just below the beak and form the beginning of the sinus when one is present. They are crossed by fine concentric striae. There are two or three strong upward curving spines, and sometimes the base of a fourth on each side of the beak. Dimensions of specimens of average and extreme size are: 1) length 7 mm, width 9 mm; 2) length 9.6 mm, width 12.2 mm.

These specimens differ from Chonetes lineatus of the Onondaga limestone in being larger, less convex, and in the number and size of the cardinal spines.

Though the greater size, less convexity, and occasional presence of a sinus seem features of sufficient importance to constitute a new species, they are not always associated in the same specimen, and there are moreover shells which appear to form a gradation from the most extreme to the more typical specimens.

STROPHALOSIA King

Strophalosia truncata (Hall)

Pal. N. Y. 4:160, pl. 23

In beds A, B, and C, of the lower shales this species is small and comparatively rare, but in the upper shaly part of bed D it is extremely abundant and of greater size. Individuals measuring 8.6 mm in length, 11.4 mm in width, and with the truncation occupying about one sixth the area of the pedicle valve are common. In bed I they are small, extremely gibbous, and with the truncation occupying about one third the area of the valve. An average specimen measures, length 4.6 mm; width 5 mm; convexity 1.9 mm.

In beds II, III, and IV, the specimens are larger, the area of the truncation decreasing in proportion to the increase in the size of the shells. The following measurements of the largest specimens observed from beds I, II, and IV, serve to illustrate

this point. I length 7.4 mm, width 8.6 mm, truncation 1.5 mm; II length 9.8 mm, width 12 mm, truncation 1.1 mm; IV length 9.4 mm, width 12 mm, truncation 1.2 mm.

The species is rare in beds III and V, only a few fragments having been found.

PRODUCTELLA Hall

Productella spinulicosta Hall

Pal. N. Y. 4:160, pl. 23

In beds VI, VII, and VIII, specimens occur, which differ from Strophalosia truncata only in their greater size and the absence of truncation of the pedicle valve. These have since been referred to Productella by Hall and Clarke,[1] "the existence of an articular system and of cardinal areas is not sufficient of itself to distinguish Strophalosia from Productella, and it will therefore be necessary to base distinctive generic value on the umbonal attachment of the former." Neither cardinal areas nor articular system has been observed in any of these specimens.

Productella dumosa Hall

Pal. N. Y. 4:162, pl. 23

This species is rare in beds II and IV. The shell is preserved on all the specimens, and the costae which form the spine bases are slightly farther apart than on specimens from the Hamilton shales. The largest specimen found has a length of 16 mm. The width could not be measured.

RHIPIDOMELLA Oehlert

Rhipidomella vanuxemi (Hall)

Pal. N. Y. 4:47, pl. 6

The species is represented by a few specimens in bed VII. The shell is retained in a fairly perfect condition. The specimens are all pedicle valves usually showing the exterior, but one shows the interior with the large muscular scars and finely striated margin of the shell. One specimen is 15.5 mm long and 18 mm wide, but the others found are much smaller.

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[1] Pal. N. Y. vol. 8, pt 1, p. 315.

CAMAROTOECHIA Hall & Clarke

Camarotoechia sappho (Hall)

Pal. N. Y. 4:340, pl. 54

Large and often gibbous specimens of the normal form are very common in beds VII and VIII. They are for the most part molds of the interior, but a few retain a portion of the shell.

Camarotoechia horsfordi Hall

Pal. N. Y. 4:339, pl. 54

This is a rare species at this locality. One nearly perfect specimen and several fragments have been found in bed VII. The former is a gibbous shell having five plications on the fold, four in the sinus, and five on the lateral slopes. It measures 14 mm in length and 17 mm in width.

Camarotoechia prolifica (?) (Hall)

Pl. 9, fig. 13–15

Pal. N. Y. 4:343, pl. 54 a

Several well preserved specimens in beds IV and V are referred with doubt to this species. They correspond in general proportions and number of plications to Prof. Hall's description and figures, but the plications are more sharply angular, and the umbonal part of the pedicle valve is distinctly elevated, and slopes abruptly to the cardinal margins. There is also a slight median depression near the beak of the pedicle valve.

Camarotoechia pauciplicata *sp. nov.*

Pl. 9, fig. 7–12

Associated with Camarotoechia sappho and C. horsfordi are specimens which differ from both in important respects. The outline of these shells is subpentagonal, the greatest width being two thirds the distance from the beak to the anterior margin. Pedicle valve slightly convex in the posterior portion but becoming depressed in the sinus and extended in front to meet the margin of the brachial valve. Beak elevated and slightly incurved. Brachial valve gibbous, the greatest con-

vexity being at about the middle of the shell. Surface marked by three subangular plications on the fold, two in the sinus, and three broad, low plications on the lateral slopes. These are crossed by well marked lines of growth. Plications absent near the beaks and becoming well defined at about one fourth the length of the shell from the beak. A well marked constriction of both valves is often present about half way between the beak and anterior margin. The interior could not be observed. The nearly straight cardinal slopes, elevated ventral beak, and few plications of the fold and sinus are the most characteristic features of the species.

This species resembles externally Pugnax utah of the upper Coal Measures, but the specimens are longer in proportion to the width, and the plications become visible nearer the beak than in the latter species. From Camarotoechia (?) duplicata, of the Chemung beds, it differs in the unequal convexity of the valves, straight cardinal slopes, and greater number of lateral plications. This species has been observed in bed VII only at Lancaster, but a similar shell has been found by the writer in material from the Stafford limestone of the Livonia shaft (N. Y. state museum).

Liorhynchus limitare (Vanuxem)

Pal. N. Y. 4:356, pl. 56

There is considerable variation among the shells referred to this species in the different beds of the section. In the shales all the specimens are excessively flattened. In the upper part of bed D, some layers of which are filled with these shells, they are of all sizes from the very young, 2 mm in diameter to those measuring 19 mm in length and 22 mm in width. In the limestones they have the normal convexity of the species, and many nearly perfect specimens were found. In bed I the shells are small, the average size being, length 5.5 mm, width 8 mm. In beds II and III, there is a gradual increase in size till in the latter bed the dimensions become, length 12.1 mm, width 15 mm, convexity 8 mm. In the uncompressed specimens the plications are

slightly if at all less conspicuous on the lateral slopes than on other parts of the shell. Small specimens, probably the young of this species, have a distinct median depression on the brachial valve. These shells have distinct radiating striae, while many of the same size in the shales show only faint traces of striae.

CRYPTONELLA Hall

Cryptonella rectirostris Hall

Pal. N. Y. 4:394, pl. 61

The species is represented in bed VII by several partially exfoliated pedicle valves. The dimensions of an average specimen are, length 4.6 mm; width 13 mm.

Cryptonella planirostris Hall

Pal. N. Y. 4:395, pl. 61

A single large specimen was found in bed VIII. It is easily recognized by the angular margins of the umbonal slopes, and the flattened areas on either side of the deltidial plates.

TROPIDOLEPTUS Hall

Tropidoleptus carinatus (Conrad)

Pal. N. Y. 4:407, pl. 62

This species is fairly represented in the lower shales, but only one specimen has been found in the limestone. The shell in bed V is much smaller than the average Hamilton specimen, but is similar in form and size to the majority of those found in the shales at Plumbottom creek. It is 7 mm long, by 8.2 mm wide. The largest specimen found in the shales has a length of 9 mm and width of 10.5 mm.

ATRYPA Dalman

Atrypa spinosa Hall

Pal. N. Y. 4:322, pl. 53a

One rather small shell of this species was found in bed V. The strong radiating plications and projecting concentric lamellae are preserved.

SPIRIFER Sowerby

Spirifer mucronatus (Conrad)

Pal. N. Y. 4:216, pl. 34

Fragments of these shells are found in beds V and VI at Plumbottom creek, and large and fairly well preserved specimens in the same beds at Cayuga creek.

Spirifer (Martinia) subumbona Hall

Pal. N. Y. 4:234, pl. 33

Young and exfoliated shells of this species are with difficulty distinguished from Ambocoelia nana, but the specimens are proportionally broader and the sinus less pronounced. The adult is larger, an average sized shell having the dimensions: length 9 mm, width 11 mm. These shells are extremely common in bed II.

RETICULARIA McCoy

Reticularia fimbriata (Conrad)

Pal. N. Y. 4:214, pl. 33

This species is represented by very perfect molds of the interior in which a part of the shell is sometimes retained. A specimen of average size measures: length 20 mm, width 29 mm. The shells are fairly common in beds VI and VII.

AMBOCOELIA Hall

Ambocoelia nana Grabau

Pl. 9, fig. 21–23

Geology and paleontology of Eighteen-mile creek, p. 217

Perfect specimens agreeing with the description of the type, abound in bed I, but in the shales below, specimens occur which show two types of variation. Here the more common form has the usual proportions of Ambocoelia nana, but the pedicle valve has an exceptionally deep sinus with strong and closely set spines. The spine pits are deep and not greatly elongated. The brachial valve has the typical convexity and broad shallow sinus. Average dimensions are: length 6 mm, width

7.9 mm. In the other form the sinus is shallow and the surface pits elongated and faintly marked. The brachial valve corresponds with the type. These specimens are also slightly larger, measuring 7 mm by 9 mm. There are, however, intermediate forms connecting these two extremes.

In bed I the average shell measures: length 5.3 mm, width 7.2 mm; but in the upper limestone beds they agree in size with the largest specimens in the shales.

TREMATOSPIRA Hall

Trematospira gibbosa Hall

Pal. N. Y. 4:272, pl. 45

A nearly perfect specimen was found in bed VII, and numerous incomplete shells in bed VIII. They are partially exfoliated, but show the characteristic punctate surface and crowded plications of the fold and sinus.

NUCLEOSPIRA Hall

Nucleospira concinna Hall

Pal. N. Y. 4:279, pl. 45

Shells of this species are rare in bed III. A few partially exfoliated specimens showing the subequally convex valves and characteristic surface markings were found. Measurements: length 7 mm, width 8.5 mm, convexity 3.5 mm.

MERISTELLA Hall

Meristella barrisi Hall

Pal. N. Y. 4:304, pl. 69

This is the most common fossil in beds VII and VIII. The shells are large, some of them extremely gibbous, and they exhibit the characteristic features of the species. Several specimens have been found in bed F immediately above the limestone.

Meristella meta Hall

Pal. N. Y. 4:308, pl. 49

A well preserved specimen in bed I is referred to this species. It differs from Meristella barrisi in the smaller size and in the presence of a distinct angular sinus beginning about one third of the distance from posterior to anterior margin. The cardinal slopes are somewhat flattened.

PELECYPODA

PANENKA Barrande

Panenka mollis Hall

Pal. N. Y. vol. 5, pt 1, p. 420, pl. 80

One specimen apparently of this species was found in bed VIII. It is smaller than the type, being only 8.6 mm high, by 9.2 mm long, but it agrees with the latter in other respects.

Panenka lincklaeni Hall

Pal. N. Y. vol. 5, pt 1, p. 420, pl. 69

This species has not been observed at the Plumbottom creek locality, but appears to be fairly common in bed I at the corner of Buffum and Seneca streets, Buffalo. The specimens are nearly perfect casts showing the flattened distant plications and rounded form characteristic of the species. A shell of average size is 59 mm long, and 50 mm high.

LEPTODESMA Hall

Leptodesma marcellense Hall

Pl. 9, fig. 16, 17

Pal. N. Y. vol. 5, pt 1, p. 175, pl. 17

Associated with specimens which show the normal characteristics of the species are others somewhat less oblique. The character and amount of variation may be seen by a comparison of the drawings here given, from specimens from beds II and V. A single nearly perfect specimen was found in bed C of the lower shales.

LUNULICARDIUM Münster

Lunulicardium fragile Hall

Pl. 9, fig. 18, 19

Pal. N. Y. vol. 5, pt 1, p. 434, pl. 71

A large, nearly perfect shell of this species was found in bed VII. It differs from the type in the greater development of the posterior expansion of the shell, a feature which is also characteristic of the majority of the specimens in the lower shales, but shells of the normal form are associated with these.

ACTINOPTERIA Hall

Actinopteria muricata Hall

Pal. N. Y. vol. 5, pt 1, p. 108, pl. 17

This species is represented in beds VI and VII by small casts of the left valve. They show the character of the surface markings and the form of the shell. The marginal spines are not preserved.

PTERINOPECTEN Hall

Pterinopecten exfoliatus Hall

Pal. N. Y. vol. 5, pt 1, p. 61, pl. 1, 83

Shells of this species are small, the largest found being only 10 mm high and 12 mm long. A part of the shell is retained and shows the surface markings. Only a few specimens have been found.

CYPRICARDINIA Hall

Cypricardinia indenta (Conrad)

Pal. N. Y. vol. 5, pt 1, p. 485, pl. 79

This is the most abundant species in bed VI. Some of the specimens retain parts of the shell, and the concentric lamellae are strongly marked on all of them, but only one shows faint traces of the fine radiating striae.

GASTROPODA

PLEUROTOMARIA De France

Pleurotomaria lucina Hall

Pal. N. Y. vol. 5, pt 2, p. 67, pl. 18

Large and well preserved, but somewhat compressed representatives of this species were found in bed VII. The shell is not retained, but the spiral and transverse striae are distinctly shown on the surface of the cast.

Pleurotomaria itys Hall

Pal. N. Y. vol. 5, pt 2, p. 76, pl. 20

The specimens of this species are rather poorly preserved casts retaining three whorls of the spire, but the form and surface markings are sufficiently distinct for identification.

Pleurotomaria capillaria *var.* rustica (Conrad)

Pal. N. Y. vol. 5, pt 2, p. 77 –

All the representatives of the species at this locality are small. A very perfect cast was found in bed II, having the dimensions: hight 5.5 mm, greatest width 6.5 mm. Three whorls are retained, all of which show the finer surface ornamentation and the spiral band.

Pleurotomaria ella Hall

Pal. N. Y. vol. 5, pt 2, p. 72

Fairly perfect molds of this shell have been found in fragments of the Stafford limestone thrown out in digging the sewer trenches on Buffum street, but the bed from which they came is not known.

Pleurotomaria sp.

In bed IV is a small species having the general shape and spiral band characteristic of the genus. The surface markings being obliterated, no specific determination could be made.

ONYCHOCHILUS Lindström

Onychochilus (?) nitidulus? Clarke

Pl. 9, fig. 20

N. Y. state geol. 13th an. rep't. 1894. p. 172, pl. 4

In bed III is found a minute sinistrally coiled gastropod which corresponds with Clarke's description and figures except that, instead of a faint carination of the whorls, there is a distinct spiral band. The concentric growth lines are interrupted in passing over this band, which is apparently partially filled by foreign matter. This feature is well shown on the body whorls of one specimen only, but, if the discovery of other specimens confirm this observation, they should be referred to the genus Hesperiella of Holzapfel rather than Onychochilus, with which I have doubtfully placed my specimens.

LOXONEMA Phillips

Loxonema *sp.*

Several longitudinal sections, having the general proportions of Loxonema hamiltoniae, were seen on the weathered surface of bed III, and a few whorls possibly of the same species in bed II.

PLATYCERAS Conrad

Platyceras (Orthonychia) attenuatum Hall

Pal. N. Y. vol. 5, pt 2, p. 6, pl. 3

A single compressed specimen was found in bed VI. The small apex and undulating lines of growth are well shown. Its length is 25 mm. and width at the peristome 20 mm.

PTEROPODA

STYLIOLINA Karpinsky

Styliolina fissurella (Hall)

Pal. N. Y. vol. 5, pt 2, p. 178, pl. 31

This species is found in bed VII of the limestones where it is sparingly represented, but it is extremely common in the shales, being found in all the beds both below and above the limestone. Nearly all the shells show a line of fracture along the median line, due to compression.

COLEOLUS Hall

Coleolus tenuicinctus Hall

Pal. N. Y. vol. 5, pt 2, p. 185, pl. 32

A single specimen in bed I, shows the faint striae characteristic of the species. Several specimens in bed III are referred with doubt to this species. The shell is replaced by finely crystallized calcite and the surface markings consequently obliterated. The largest specimen observed has a length of 65 mm and greatest diameter of 5 mm.

CEPHALOPODA

ORTHOCERAS Breyn

Orthoceras exile Hall

Pal. N. Y. vol. 5, pt 2, p. 290, pl. 39, 84, 85

This species is fairly common in beds I, II and III. The specimens are molds of the interior. The apical angle is about 6°, and the depth of the air chambers is from 3 to 5 mm. The largest specimen is 75 mm long, and retains a part of the living chamber and 12 septa.

Orthoceras marcellense Vanuxem

Pal. N. Y. vol. 5, pt 2, p. 278, pl. 38, 39, 93

This species, like O. exile, is represented by internal molds which are somewhat compressed. They are identified by means of the distant septa and regularly enlarging tube. The apical angle is 8°, and the depth of the air chambers 6 to 8 mm. The largest specimen is 125 mm long, and a part of the living chamber and nine septa are preserved. The position of the siphuncle could not be determined.

Orthoceras eriense Hall

Pal. N. Y. vol. 5, pt 2, p. 274, pl. 40

A fine specimen of this large species was found in bed VII. It is 180 mm long, and 45 mm wide at the smaller end. It shows a part of the chamber of habitation and nine air chambers, which vary in depth from 9 to 13.5 mm. The apical angle is 7.5°.

The surface of this Orthoceras is covered with Bryozoa, Crania, and Spirorbis.

Orthoceras aegea Hall

Pal. N. Y. vol. 5, pt 2, p. 295, pl. 82

The representatives of this species in the limestone are small, the most perfect specimen being only 14.5 mm long, and having a greatest diameter of 6 mm, but fragments of a larger specimen were found. In bed F of the upper shales large specimens were found and fragments of the shell retain all the characteristic features of the surface.

Orthoceras fenestrulatum Clarke

N. Y. state geol. 13th an. rep't. 1894. 1:168, pl. 2

In bed VIII a large internal mold was found to which bits of the shell still adhere. It is 53 mm long, and has a greatest diameter of 29 mm. The surface ornamentation has been sufficiently impressed on the mold to show its character distinctly. Other specimens are portions of the thin shell, showing the inner surface and the external ornamentation reversed.

NEPHRITICERAS Hyatt

Nephriticeras bucinum (Hall)

Pal. N. Y. vol. 5, pt 2, p. 412, pl. 106, 107, 109

A large cast showing distinctly the finer surface ornamentation and the position of the septa was found in bed VII. Its length is 70 mm and greatest diameter 44 mm. Portions of the surface are overgrown with Bryozoa.

CRUSTACEA

TRILOBITA

PHACOPS Emmrich

Phacops rana (Green)

Pal. N. Y. vol. 7, p. 19, pl. 7, 8, 8a

This species is common in the lower limestone beds and sparingly represented in the upper. Portions of the cephalon and pygidium were found. Some of the specimens referred to

this species show the protuberant glabella characteristic of Phacops cristata, but the lateral crenulations of the submarginal furrow are absent, and other features characteristic of the species are not shown.

CRYPHAEUS Green

Cryphaeus boothi Green

Pal. N. Y. 7:42, pl. 16, 16a

This is a rare species at Plumbottom creek. It is represented by fragments of the cephalon and pygidium. A small specimen in bed V shows the genal spines and strongly pustulose glabella.

CYPHASPIS Burmeister

Cyphaspis craspedota Hall

Pal. N. Y. 7:148, pl. 24

A few specimens of this species have been found in beds V and VII. A cephalon from bed V shows the pustulose glabella, palpebral lobes, marginal sulcus and one genal spine. It is 4 mm long, and 8 mm wide. The spine is 2.8 mm in length.

OSTRACODA

PRIMITIOPSIS Jones

Primitiopsis punctulifera Hall

N. Y. state mus. 13th an. rep't. 1860. p. 92

This is a rare fossil at this locality, but when found the shells are usually well preserved, showing the form and reticulated surface markings.

From a consideration of the lithologic character of the different beds, at this locality, and the size and distribution of the contained fossils, successive changes in physical conditions may be inferred. Though the change from shale to limestone was a somewhat abrupt one, the limestone at first retained considerable carbonaceous material, as shown by the dark color and limited number of species in bed I. In beds II and III a gradual clearing of the water is indicated by the increasing purity of the

limestone, which, in bed III is fine grained, hard, and light colored. Bed D marks, by its darker color, a tendency to return to former conditions, and V and VI are impure and somewhat shaly limestones. The changes in physical conditions thus indicated are reflected, as one might expect, in the character and condition of the organic remains. Thus, there is a gradual increase in size as well as in number of species from bed I to bed III, while the reverse is true from bed IV to VI, in which a small lamellibranch becomes the most abundant fossil. These are succeeded by a return to clear water conditions, for VII and VIII are to an even greater extent than bed III pure hard limestones containing a great abundance and variety of fossil remains. As already noted, they represent the time of maximum development of the fauna. The change to muddier waters and a Marcellus fauna is an abrupt one, as indicated by the thin bedded dark shales and Liorhynchus fauna of bed F.

CONCLUSION

The base of the Marcellus is reported by Prof. I. P. Bishop[1] to be 20 feet below the limestone layers. The thickness of the limestone is 8 feet, 4 inches, and the estimated thickness of the Marcellus in western New York 140 feet. The top of the limestone must therefore be not less than 111 feet below the base of the Hamilton. Though occurring so far below the latter formation, the fossils of the Plumbottom creek limestones are, as indicated by the foregoing lists, largely Hamilton species with a few typical Marcellus forms and several persistent species from the Onondaga limestone.

Of the 72 species recognized from the limestone at Lancaster 54 occur in the Hamilton, 15 species are common to both Hamilton and the Marcellus shales, eight are exclusively Marcellus, 11 have been reported from the Onondaga limestone, and two are restricted to the Stafford limestone. The shales below and above the limestone contain typical Marcellus fossils. It will thus be seen that the conditions favorable to the formation of the thin bedded dark shale, with its characteristically Marcellus

[1] Structural and economic geology of Erie county, p. 314.

fauna, was succeeded by a limestone-making epoch with clearing waters, and a typical Hamilton fauna which had migrated from some, at present, unknown locality. This was followed by a return of the Marcellus fauna when the waters were again more shallow and less pure.

The existence of a Hamilton fauna in the Stafford limestone at Stafford and Livonia has already been noted by John M. Clarke.[1] His list of species for both localities comprises two Anthozoa, one Crinoid, four Bryozoa, 27 Brachiopoda, 10 Lamellibranchiata, 14 Gastropoda, one Pteropod, 10 Cephalopoda, six Arthropoda and one Annelid, a total of 76 species, of which two Bryozoa, 16 Brachiopoda, three Lamellibranchiata, five Gastropoda, two Pteropoda, three Cephalopoda, and three Arthropoda, a total of 34 species, have been found at Lancaster, that is, about half the total fauna of the Lancaster limestone is present in the Stafford limestone. The most characteristic species of the section under consideration are *Strophalosia truncata*, *Spirifer subumbona*, *Meristella barrisi*, *Camarotoechia sappho*, *Phacops rana*, *Orthoceras marcellense*, *O. exile*, *Liorhynchus limitare*, *Reticularia fimbriata*, and *Cypricardinia indenta*, of which the first six are found in the Stafford limestone.

A comparison of material from the Stafford limestone of these localities in the New York state museum at Albany reveals a close correspondence in lithologic character and fossils with beds VII and VIII, 15 species restricted to these two upper beds being found in the Stafford limestone. *Liorhynchus limitare* which is common in the lower beds is absent from the three upper beds of the section and absent also from the sections cited. The thickness of this limestone is given as from 18 inches to 2 feet, while the combined thickness of beds VII and VIII is 2 feet 2 inches. These facts seem to warrant a definite correlation of beds VII and VIII with the 2 feet of limestone exposed at Stafford.

[1] In work cited, and Succession of the fossil faunas in the section of the Livonia salt shaft: N. Y. state geol. 13th an. rep't. 1894. p. 131.

Farther east the thickness of the Stafford limestone is shown by borings in various salt shafts to be 1.8 feet at Leroy; and in Livingston county, 4 feet at York, 1 foot at the outlet of Conesus lake, and 2 feet at Livonia. Westward the conditions appear to be somewhat different, for at the Plumbottom creek locality, only about 30 miles west from Stafford, the thickness is 8 feet 4 inches. The only locality between these places at which the Stafford limestone has been observed is at Wende station on the Lehigh railroad. The contact between the lower Marcellus shales and bed I is well exposed on the left bank of the stream opposite the station. Large boulders, some of which belong to higher beds of the Lancaster section, are scattered along the stream channel to the southward for a distance of ½ mile or more but there are no exposures from which the thickness of the limestone could be estimated. An outcrop supposed to be of this Stafford limestone occurs on the farm of Martin Martin ½ mile east of Alden Center, but this proved on examination to belong to the Onondaga formation. The exposure is due to the removal of the surface soil over an area 3 or 4 yards square, and the rock has been blasted, fragments of it having been thrown out on the surface. The rock resembles the Stafford limestone lithologically but the fossils are mainly corals of the genera Favosites, Zaphrentis, Heliophyllum and Blothrophyllum, B. promissum being the most common species. The following are a few of the fossils observed at this locality.

Zaphrentis prolifica *Billings*
Z. gigantea (?) *Lesueur*
Z. herzeri (?) *Hall*
Z. *sp.*
Blothrophyllum promissum *Hall*
Cyathophyllum (Heliophyllum) juvenis *Rominger*
Heliophyllum corniculum (*Lesueur*)
Favosites epidermatus *Rominger*
F. hemisphericus *Troost*

Syringopora *sp.*
Pentamerella arata (*Conrad*)
Reticularia fimbriata (*Conrad*)
Phacops rana (*Green*)

The contact between the Marcellus and Onondaga is supposed to be about half way between Wende station and Mill Grove.[1] The eastward extension of this line of contact would carry it about a mile north of the outcrop of Onondaga limestone at Alden. The occurrence of the latter limestone so far to the south may perhaps best be accounted for by postulating a gentle undulation of the strata in this region. Only a slight elevation need be assumed, for the top of the Onondaga is reported to be only 20 feet below the Stafford limestone, and the locality at Wende where the base of the latter is exposed is about 2½ miles from the outcrop of Onondaga at Alden. An elevation, therefore, of 20 feet in a distance of 2½ miles would be sufficient to bring the Onondaga to the surface, and the extent of deflection of the outcrop would depend on the shape of the fold.

West of Lancaster an outcrop of limestone in the bed of Buffalo creek below Gardenville appears, from its lithologic character and its relations to the Marcellus shales, to correspond with bed H of the Plumbottom creek section.

The Stafford limestone was passed through in digging the sewer trenches near the corner of Buffum and Seneca streets, but for the thickness at this locality no accurate data could be secured. Another exposure of Stafford limestone in Erie county is mentioned by Bishop at the point where the Buffalo, Rochester and Pittsburg railroad diverges from the Western New York and Pennsylvania, and the Lake Shore railroads, but the thickness is not given. From these facts it appears that the limestone forms as bed rock, a band approximately ⅛ to ½ a mile wide extending across the county in a slightly southwest direction from the vicinity of Wende station to Lake Erie.

The rapid increase in thickness in the comparatively short distance between Stafford and Plumbottom creek and the

[1] Bishop. Structural and economic geology of Erie county.

correlation of the two upper beds of the sections at the latter place with the Stafford limestone suggests the possibility of correlating beds I to VII with the lower Marcellus rather than with the Stafford limestone. To this may be objected the continuity of the Plumbottom creek limestones and their fauna, and the occurrence of characteristic Stafford species throughout the section. The prevailing species in the Stafford limestone at Livonia, as given by Clarke, are: Strophalosia truncata, Chonetes scitulus, Meristella barrisi, Camarotoechia horsfordi, and Phacops rana. Of these Strophalosia truncata, Chonetes scitulus, and Phacops rana are characteristic of the lower, and Meristella barrisi, and Camarotoechia horsfordi of the upper beds.

Beds I to IV as well as VII and VIII are, like the typical Stafford limestone, a dark subcrystalline rock when fresh, weathering gray and with the substance of the fossils altered to a dark crystalline calcite. The difference in the thickness may be accounted for by the fact that the section at Stafford has never been described in full, and it may be either that the lower calcareous beds of the Lancaster section are wanting or that they are concealed there.

Notwithstanding the differences noted above between the faunal lists from Stafford and Plumbottom creek the section at the latter place exhibits all the more characteristic features of the Stafford limestone fauna, and there is no break either lithologically or faunally sufficiently marked to warrant a correlation of the lower and upper portions of the section with different formations. We may therefore conclude that the section at Lancaster represents the westward extension of the Stafford limestone, but with greater thickness and differentiation into distinct beds, of which the lower may be absent at Stafford or more probably, concealed at that place.

Vertical distribution of the Stafford limestone fauna at Lancaster N. Y.

	LANCASTER															NEW YORK STATE OTHER THAN LANCASTER			
	Marcellus shale					Marcellus limestone								Marcellus shale		Onondaga limestone	Marcellus shale	Stafford limestone	Hamilton
	A	B	C	D	E	I	II	III	IV	V	VI	VII	VIII	F	G				
Actinopteria muricata	---	---	---	---	---	---	---	---	---	---	X	X	---	---	---	---	X	X	---
Ambocoelia nana	---	X	X	X	X	X	X	X	X	X	---	X	X	---	---	---	X	---	X
A. praeumbona	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	X
A. umbonata	---	---	---	---	---	---	---	---	---	---	---	---	---	X	---	X	X	X	X
Atrypa spinosa	---	---	---	---	---	---	---	---	---	X	---	---	---	---	---	X	---	---	X
A. reticularis	---	---	---	---	---	---	---	---	---	---	---	---	---	X	---	X	X	X	X
Aulopora sp	---	---	---	---	---	---	---	---	---	---	---	X	---	---	---	---	---	---	---
Aviculopecten exacutus	---	---	X	X	---	---	---	---	---	---	---	---	---	---	---	---	X	---	X
Camarotoechia horsfordi	---	---	---	---	---	---	---	---	---	---	---	X	---	---	---	---	X	X	X
C. pauciplicata	---	---	---	---	---	---	---	---	---	---	---	X	---	---	---	---	---	X	---
C. prolifica ?	---	---	---	---	---	---	---	---	X	X	---	---	---	---	---	---	---	X	X
C. sappho	---	---	---	---	---	---	---	---	---	---	X	X	X	---	---	---	---	X	X
Ceratopora dichotoma	---	---	---	---	---	---	---	---	---	X	---	---	---	X	X	---	---	---	X
C. jacksoni	---	---	---	---	---	---	---	---	X	X	---	---	---	---	---	---	---	---	X
Chonetes lepidus	---	---	---	---	---	---	---	---	---	---	---	X	---	X	---	---	X	X	X
C. mucronatus	X	X	X	X	---	X	X	X	X	X	X	X	X	---	---	X	X	X	X
C. scitulus	---	---	---	---	X	---	X	X	---	X	X	---	---	---	---	---	X	X	X
Coleolus tenuicinctum	---	---	---	---	---	---	X	X	---	---	---	---	---	---	---	---	---	---	X
Crania crenistriata	---	---	---	---	---	---	---	---	---	---	---	X	---	---	---	---	---	---	X
C. recta	---	---	---	---	---	---	---	---	---	---	---	X	---	---	---	---	---	---	---
Craniella hamiltoniae	---	---	---	---	---	---	---	---	X	---	---	X	X	---	---	---	X	X	X
Cryphaeus boothi	---	---	---	---	---	---	---	---	---	X	X	X	---	---	---	X	---	X	X
Cryptonella planirostris	---	---	---	---	---	---	---	---	---	---	---	X	X	---	---	---	---	X	X
C. rectirostris	---	---	---	---	---	---	---	---	---	---	---	X	---	---	---	---	---	---	X
Cyphaspis craspedota	---	---	---	---	---	---	---	---	---	X	---	X	---	---	---	---	---	X	X

	LANCASTER														NEW YORK STATE OTHER THAN LANCASTER			
	Marcellus shale					Stafford limestone								Marcellus shale		Onondaga limestone	Marcellus shale	Stafford limestone	Hamilton
	A	B	C	D	E	I	II	III	IV	V	VI	VII	VIII	F	G				
Cypricardinia indenta									X		X		X			X			X
Favosites placenta											X	X							X
Fistulipora ? sp.										X									
Goniatites ?		X		X															
G. vanuxemi (?)			X																
Hederella canadensis												X						X	X
H. cirrhosa									X			X							X
Isochilina (?) fabacea	X	X	X	X	X														X
Leptodesma marcellense			X				X	X		X							X		
Liorhynchus limitare	X	X	X	X		X	X	X	X	X				X	X		X		
Loxonema sp.							X	X											
Lunulicardium curtum			X																
L. fragile	X	X	X	X	X							X		X			X	X	X
Meristella barrisi								X				X	X	X				X	X
M. neta						X													X
Modiomorpha subalata	X	X	X														X		X
Nephriticeras bucinum												X							X
Nucleospira concinna								X								X			X
Nuculites nyssa	X	X	X														X		X
N. triqueter		X	X	X	X												X		X
Onychochilus (?) nitidulus (?)							X	X										X	
Orthoceras aegea												X						X	X
O. eriense												X							X
O. exile						X	X	X											X

Orthoceras fenestrulatum													x	x				x	
O. marcellense							x					x	x				x	x	
O. subulatum	x	x	x	x	x												x	x	x
Orthonota parvula					x														x
Orthothetes chemungensis arctostriata												x	x					x	x
Palaeoneilo sp							x												
Panenka linckleani					x	x											x	x	
P. mollis													x				x		
P. rana							x	x	x	x	x	x	x	x		x	x	x	x
Platyceras (Orthonychia) attenuatum											x							x	x
Pleurotomaria capillaria rustica							x										x	x	x
P. itys							x	x										x	x
P. lucina												x				x		x	x
P. rugulata			x														x	x	
P. ella																			x
P. sp									x										
Primitiopsis punctulifera	x				x		x	x					x						x
Productella dumosa							x		x										x
P. spinulicosta										x	x						x	x	x
Pterinopecten exfoliatus										x	x							x	
Reptaria stolonifera											x						x	x	x
Reticularia fimbriata										x	x					x	x		x
Rhipidomella vanuxemi											x	x						x	x
Schizobolus truncatus								x											x
Spirifer mucronatus										x							x		x
S. (Martinia) subumbona							x	x	x	x		x						x	x
Spirorbis sp									x			x	x						
Stereolasma rectum												x	x						x
Stictopora sp										x									
Strophalosia truncata	x	x	x	x		x	x	x	x	x							x	x	x
Stropheodonta inequistriata												x				x		x	x
S. perplana												x	x			x			x
Styliolina fissurella	x	x	x	x								x		x	x			x	x
Tentaculites gracilistriatus											x		x				x	x	x
Trematospira gibbosa												x	x						x
Trematopora (Orthopora) tortalinea											x								x
Tropidoleptus carinatus		x		x						x									x

NEW AGELACRINITES

BY JOHN M. CLARKE

Pl. 10

Some interesting specimens of new agelacrinites have been acquired recently from the upper Devonic and supradevonic sandstones in southwestern New York and northeastern Pennsylvania. The first suggestion of these came to my notice several years ago through the kindness of E. B. Hall esq. of Wellsville, who presented me with a hand-size slab bearing impressions of the aboral surface of four large disks, with parts of not less than five others. This specimen was a loose Chemung sandstone slab found at Belvidere, Allegany co. Subsequently another specimen similarly preserved was found loose near Wellsville. Though the novelty of this species to our Chemung faunas was recognized, the specimens were laid aside to await more light on the essential characters of the organism. Through the assiduity of two zealous students of the Chemung fauna, Laurence LaForge and Prof. Charles Butts of Alfred N. Y., the desired facts have arrived. These gentlemen have brought to light in the vicinity of Alfred a very considerable number of specimens of this agelacrinite, displaying variations in size that indicate different stages of growth and in a large majority of cases affording the oral exposure. Mr Butts has also obtained specimens of this organism at a locality 2 miles south of Sabinsville, in the town of Clymer, Tioga co. Pa. and these, by the courtesy of the director of the U. S. geological survey I have been allowed to study and figure. While discussing the structure of this species, I shall provisionally refer to it as A. allegan i u s. The state museum has come into possession of an excellent series of these novel fossils.

While engaged in field work on the Olean quadrangle during the season of 1900, Mr Butts also obtained from a very high horizon in the sandstones of that region another small and rather

obscure agelacrinite, fuller reference to the structure and stratigraphic position of which will be made, and which will now be termed A. b u t t s i. Prof. Beecher of New Haven has kindly called my attention to a specimen of this species obtained by him from approximately the same horizon in the rock section at Warren Pa., and has also placed in my hands for study a new species from a higher horizon in the early Carbonic strata at the same place. This we refer to as A. b e e c h e r i.

The fauna of the Chemung beds is one of constant surprises, and in its arenaceous deposits, in places crowded with long known brachiopods, lamellibranchs, etc. it is the unexpected that happens to the persistent searcher. The vast amount of material brought in from these rocks for the study of the fauna of the period as described in the various volumes of the *Paleontology of New York* produced none of these agelacrinites, nor of the remarkable phyllocarid crustaceans described by Prof. Beecher and by the writer, of the limuloid described by Prof. H. S. Williams, nor of the starfishes recently obtained by the collectors of this department for the state museum, and but very few of the hexactinellid sponges of which the late Prof. Hall and the writer have described 70 species. This fauna should appeal to collector-students, who may be blessed at any turn therein with paleontologic surprise and gratification.

That the agelacrinites under special consideration were not after all extremely rare members of the Chemung fauna, is testified by a slab bearing 13 impressions, now the property of Mr LaForge, the finder. One slab owned by the museum bears seven individuals exposing the oral surface, and another nine with aboral exposure.

In studying these organisms, which their novel relation to our ancient fauna and their interesting biologic character entitle to description and illustration, a comedy of errors in the nomenclature and determination of its allies among the Agelacrinitidae reveals itself. If, therefore, these bodies prove a means to unsnarl the tangle of names into which American paleontologists with the aid of their British and German brethren have plunged

these organisms, they may thereby also do a service. Before, then, proceeding to a special account of these bodies I shall undertake a brief historical exordium. Without this one dare not employ the outstanding generic names.

The term, Agelacrinus, employed even by so late and accomplished an author as Bather[1] is not entitled to the respect it has received. It has been long in use, but usage can not be granted to play as important a part in the construction of a scientific nomenclature as in the building of a language. *Agelacrinites* was the original form of the word as employed by Vanuxem for his unique fossil, A. hamiltonensis.[2] A later well intentioned writer conceived it wise to drop the *ites* and add the *us*, as was then doing with names of crinoidal genera which had been terminated with the former syllables. Not only are the author's rights conserved, but the differentials of the genus are indicated by the retention of the original word. Various distinguished authors, Meek and Worthen, Billings and Jaekel have eschewed the substitute, but the wrong word is still in active service.

Meek and Worthen[3] were the first to recognize by name what they believed to be a generic difference between the middle Devonic Agelacrinites and the species from the Siluric and lower Carbonic which were all being included under that name; a difference in the character of the plates, imbricating in the latter and juxtaposed in the former; and in the direction of the arms, two of the five being dextral (solar[4]) in the former, and but one dextral in the latter. They proposed to distinguish the latter by the term, Lepidodiscus, and, as this name was employed first in connection with their species, A g. (L e p.) s q u a m o s u s of the Keokuk limestone, we must assume this to be the type species of that proposed division. Thus restricted it is clear that

[1] Lankester's Treatise on zoology. 1900. pt 3.

[2] Geol. N. Y. 3d geol. district. 1842. p. 158, fig. on p. 306.

[3] Geol. sur. Ill. 1873. 5:513.

[4] Jaekel proposes to distinguish the rays in these bodies according to their direction by comparing them to the apparent motion of the sun or the course of the hands of a clock. Thus right under to left and over to right (dextral) is *solar*, the opposite direction (sinistral) *contrasolar*. The terms are helpful and we have here employed them.

the name can not appropriately be applied to Siluric forms like A. cincinnatiensis.

Let us take a short step backward. Prof. Hall in 1868[1] had described an agelacrinite from the Kaskaskia (Chester) limestone (Kaskaskia Ill.) as Agelacrinites kaskaskiensis. The figure of the specimen represented five long and slender arms, all directed up and over to the left (sinistral or contrasolar), but the description ascribes six rays to the fossil. Meek and Worthen having the type specimen before them, pointed out that there were but five arms, and that, if there was an appearance of a sixth, it was due to an imperfection in the specimen. Prof. C. A. Rolfe of the Illinois state university has kindly provided me with a photograph and squeeze of this original, from which it is clear, not only that there are indeed five rays, but that they are not all contrasolar, as represented by Hall and also in the figure reproduced by Keyes,[2] but that only four are contrasolar, while the fifth is solar; and in this respect at least the species conforms to the type of Lepidodiscus. To the other features of its structure subsequent reference will be made.

FIG. 1 The original specimen of A. kaskaskiensis Hall showing R 1–4 contrasolar, R 5 solar, and the mosaic pavement of the interradii. Natural size

In 1883 Worthen and Miller[3] introduced the generic term, Echinodiscus, with a single species, E. optatus, from the Chester limestone of Illinois. The single figure given of the species, and all that has ever been presented, shows what is alleged to be a segment of the aboral surface. Of itself it serves to define nothing, affording no clue either to generic or specific structures. As establishing either species or genus it is practically worthless. Notwithstanding this fact, the definition given of both species and genus is full and clear, describing all the main features of the theca and ambulacra. One can not fail of conviction, nor therein be far from the truth, that in the

[1] Geol. Iowa. v. 1, pt 2, p. 696, pl. 25, fig. 18.
[2] Geol. Missouri. Pal. 1894. v. 4, pt 1, p. 133, pl. 18, fig. 3.
[3] Geol. sur. Ill. 8:335, pl. 31, fig. 9.

preparation of this account the authors were relying mainly on the original specimen of A g e l. k a s k a s k i e n s i s Hall, which belonged to the Worthen collection. That E c h. o p t a t u s W. & M. is not the same thing as A. k a s k a s k i e n s i s has not been proven, and every indication favors the presumption that it is. Side light is thrown on this proposition by two facts, viz, that in the description of Echinodiscus and E. o p t a t u s, the remotest reference to A. k a s k a s k i e n s i s is avoided, and also that in the edition of Miller's *North American geology and paleontology* (1889) next succeeding the date of Worthen and Miller's publication, A. k a s k a s k i e n s i s is referred to Echinodiscus. The basis of the genus Echinodiscus was laid mainly on the constitution of its interradial plating, which is not imbricating but mosaic, on the mode of departure of the ambulacra from the oral aperture and the narrowness of the rays, but nothing is said concerning the direction of the rays.

Mr Miller subsequently described[1] another species of this genus, E. s a m p s o n i, from the Keokuk group at Boonville Mo., a highly incomplete fragment of the oral surface, which nevertheless shows narrow, undulating ridgelike rays and a mosaic of polygonal interradial plates. Except for its larger size there is little to distinguish it from A. k a s k a s k i e n s i s.

So far then it appears that a quite distinct type of structure among the agelacrinites has been founded on specimens one of which was fairly complete but incorrectly described, a second audaciously fragmentary and imperfect and a third likewise imperfect but affording some important details.

The specimen for which F. Roemer proposed the name Haplocystites (H. r h e n a n a, 1851) has recently been figured by Jaekel (*Stammesgeschichte der Pelmatozoen.* 1899. pl. 3, fig. 3). This is an internal cast showing two rays and part of a third. These are quite narrow and have the general aspect of those of Agelacrinites while the plates are polygonal and mosaic. The surfaces of these plates are smooth as in E c h i n. s a m p s o n i and A. k a s k a s k i e n s i s but as the specimen

[1] Geol. sur. Ind. 17th an. rep't. 1891. p. 76, pl. 12, fig. 16.

shows only the under surface, it is not yet possible to state that they were not sculptured exteriorly like A. h a m i l t o n e n s i s. Jaekel thus has wisely regarded Haplocystites synonymous with Agelacrinites. Future knowledge of this fossil may indicate that Haplocystites is the proper designation for the bodies which have been termed Echinodiscus or Lepidodiscus.

Agelacystis is a name proposed by Haeckel as a substitute for Agelacrinites because the latter is not a crinoid. It has no standing whatever.

Great minds have ever thought in unison. And so it came about that in the year 1897 it was discovered by the acute American paleontologist, Mr. Miller,[1] and by the distinguished English geologist and explorer, Dr J. W. Gregory,[2] that the term Echinodiscus had long ago been employed as a generic name among the Echinoderma, and hence its duplication was inadmissible. Mr Miller exercised his preeminent right to correct his error by proposing to replace the unintended synonym with the word, Ageladiscus.[3] This was in October of that year, but already in February Dr Gregory had introduced the term, Discocystis, with the same intent.

Thus three different generic names have been introduced for three very dubious specimens of agelacrinites, of which two doubtless belong to the same species and of all three of which very little has been known. No wonder that the eminent English echinodermist, Dr Bather, in a late work should indicate a sluggish receptivity for these names.[4]

This is the nomenclatorial history to the present of these peculiar bodies. Our new material from the Chemung sandstones enables us to carry it forward, and it is hoped at the same time to elucidate these polynomial structures.

The Chemung agelacrinite (A. a l l e g a n i u s), like all its later allies, was sessile but not fixed. No specimen has been seen

[1] North American geology and paleontology. 2d appendix, p. 744.
[2] Quar. jour. geol. soc. 1897. 53: 123–36.
[3] North American geology and paleontology. 2d appendix, p. 734.
[4] Lankester's Treatise on zoology. 1900. pt 3, p. 203.

attached to any other body, and yet all that have been found occur in clusters. The aboral surface is gently depressed, with large marginal plates projecting downward as a peripheral ring. On the oral surface the five ambulacra are extremely narrow, directed radially, and when near the periphery bend abruptly to the right (contrasolar) and are extended like whiplashes parallel to and very near the periphery, slightly undulating in their course. These narrow ambulacra are covered with very fine interlocking, triangular, arching cover plates. The thecal plates on both aboral and oral surfaces are imbricating or have that appearance.[1]

This organism resembles A g e l. k a s k a s k i e n s i s, E c h i n. s a m p s o n i (E c h i n o d i s c u s - D i s c o c y s t i s - A g e l a - d i s c u s) and L e p i d o d i s c u s s q u a m o s u s in the narrow, whiplike character of its rays. It differs from the two former (but not from Lepidodiscus) in the squamous aspect of the thecal plates and from all in the uniform contrasolar direction of all the rays.

We can not hope to arrive at a proper or approximate generic designation for this and related agelacrinites unless we undertake here to consider briefly what constitutes the values of certain morphologic features in this group of species.

Thecal plates. The earlier or Siluric agelacrinites have a squamous surface of imbricating plates; A. a l l e g a n i u s of the Chemung and the lower Carbonic A. s q u a m o s u s and A. b l a i r i have the same. The middle Devonic A. h a m i l t o n e n s i s has irregularly shaped mosaic thecal plates with sculptured and ridged surfaces, while the Carbonic species of the "Echinodiscus" group have smooth and regular polygonal mosaic plates.

In many species a circular wall bounding the apexes of the rays is built of large and strong plates supported on the periphery by much smaller plates (A. h a m i l t o n e n s i s) or

[1] It may be doubtful whether on the interradii and aboral surfaces these plates always actually overlap each other as they clearly do in the peripheral region. They have a scaly appearance which may be due to the greater thickening at the inner or proximal edges on both surfaces.

the larger plates may themselves be peripheral and project downward below the level of the aboral surface (A. alleganius) or all the marginal plates be of uniform and small size (A. cincinnatiensis), with the peripheral area outside the circular wall very broad (A. buttsi, A. legrandensis) or these plates be both large and small (A. dicksoni).

Agelacrinites holbrooki James of the upper Siluric has the interradial spaces paved with a mosaic of five and six sided plates, while the marginal plates are imbricating.[1] This condition, though pronounced in this species, is also apparent in less degree in all species with mosaic plates over the interradii. Such a combination of plating would seem essentially to neutralize the influence of the character of the thecal plates alone as a generic feature, when considered independently of other structure. It was the difference in this respect indicated by the first species above mentioned, together with a difference in the attitude of the rays, that furnished to Meek occasion for introducing his term, Lepidodiscus, for the squamous forms.

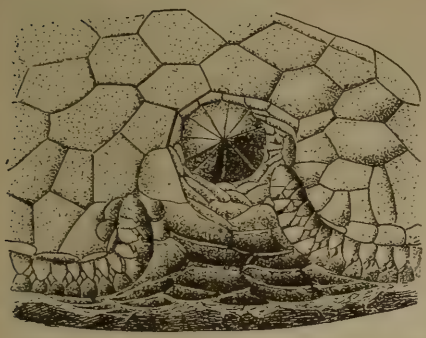


FIG. 2 A. holbrooki James. Anal region much enlarged, showing the mosaic plates of the interradii, the squamous plates of the margin, the crowding of small plates about the anal pyramid and the terminations of R 1 and 5. Between the cover plates of the latter will be observed minute accessory plates, two for each interval.

Madreporite. Dr Bather has indicated the presence of a madrepore in his copied figures of A. cincinnatiensis and A. hamiltonensis (*op. cit.* p. 205). I have, however, seen nothing in any agelacrinite that can be safely thus designated.

Rays. *Direction.* Of the species of "Agelacrinus", some of the early Siluric forms like A. billingsi Chapman of the Trenton and A. bohemicus Barr. (Étage D), have the rays sharp and quite straight, abutting against or tapering to a broad margin of larger and smaller plates. In others the rays are all solar, as in A. alleganius,

[1] Cin. soc. nat. hist. Jour. 1887. 10:25.

or all contrasolar, as in A. dicksoni Billings (Trenton). Four rays contrasolar and one solar is the usual expression, as shown by A. (Lepidodiscus) squamosus Meek and A. (Echinodiscus) kaskaskiensis Hall of the Keokuk and Chester groups of the lower Carbonic, A. cincinnatiensis Roemer, A. holbrooki and A. pileus Hall of the Cincinnatian group. In A. hamiltonensis Vanux. (middle Devonic) two are solar and three contrasolar. Even the number of the rays seems not to be always five, as Faber has described a species supposed to have seven rays, (A. septembrachiatus; Cincinnatian) and Miller and Gurley one with but four (A. legrandensis; Kinderhook).

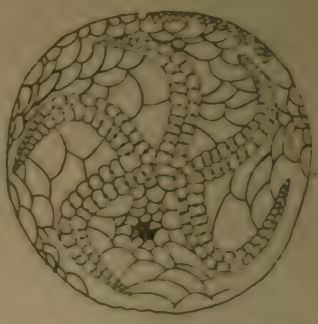


FIG. 3 A. dicksoni Billings x 1½ showing the five contrasolar rays and the ambulacral plates which were regarded as perforate by Billings (From Ottawa field nat. club. Trans. 2. 1881. plate fig. 9)

Young specimens of A. alleganius, A. buttsi and of the A. hamiltonensis show that the ambulacral rays in early growth extended in direct radial lines to the margin or elevated submarginal wall. They did not however pass on to the aboral surface, though in A. alleganius they reach the margin, but in the young of A. hamiltonensis and A. buttsi these rays abut directly against a highly developed ridge. The final course of the rays is then not determined except with the approach of mature conditions, but is nevertheless constant, and we have no record of any departure from the regularity and uniformity of their direction in a given species or homogeneous group of species.

This feature is notably one in which specific character is not expressed or suggested before the commencement of mature growth, and it seems therein to lose all value as a feature of higher (generic) distinction, though persistent as a specific character. The primitive direction of these rays is repeated in the adult expressions of the earlier agelacrinites, as cited above.

Size, length and structure. Among the Agelacrinitidae (re-

stricting the family by the limits drawn by Bather and Jaekel, and leaving out of present consideration the genus Edrioaster) it is a notable fact that the rays are broadest and shortest in the earlier species. This is very noticeable throughout the considerable array of Siluric species, A. billingsi, cincinnatiensis, holbrooki, dicksoni, etc. In the early and middle Devonic (A. hamiltonensis; A. rhenanus, upper lower Devonic, Unkel, Rhine) the rays have become slender and very long, but the most extreme expressions of these characters are to be seen in the species of still later age. It naturally ensues from this narrowing of the ambulacra that the composition of these areas with the usual preservation of the fossils becomes much obscured in later forms. Billings claimed that in the Trenton species A. dicksoni, perforated ambulacral plates were exposed, but this observation has not been confirmed and Jaekel holds that no ambulacral plates were present in these bodies. At all events usually only the cover plates have been observed. The later whiplash rayed species A. alleganius, A. beecheri, A. lebouri, A. (Echinodiscus) kaskaskiensis, A. (E.) sampsoni, A. (Lepidodiscus) squamosus, show only rows of small, arched, angular cover plates more or less completely interlocking at their edges.

Mouth and oral plates. The oral aperture is somewhat elongated in all forms of true Agelacrinites, and in some it has been represented as covered with a few large oral plates. This structure has, however, seldom been clearly made out except for some of the Siluric species. In A. hamiltonensis, as shown in the accompanying figure of the type specimen (pl. 10, fig. 6) it is somewhat schematic. Meek, on the other hand, represents the oral region of A. squamosus as covered by a multitude of minute plates, but as no special mention is made of the oral structure in his description, I infer that this also is somewhat restored. In his description of Echinodiscus and E. optatus, Miller makes special mention of the fact that the rays do not depart from a central point, but that this point of departure (oral opening) is elongated, two rays

departing from each extremity and the fifth from the side. This is a condition which is common to most true agelacrinites, but it is very much more pronounced in all postsiluric species, being no doubt emphasized in expression by the more slender rays.

Anal pyramid. The valved anal aperture may be situated centrally or laterally in an interradius. It is interesting to note that, whenever a reversal is present among the rays, it invariably affects that adjoining this aperture, so that the pyramid lies in a subcircular interradius bounded by the concave curves of neighboring rays, as though indeed the function of alimentation were conserved by this close approach of the ambulacra.

Mode of growth. These bodies divide themselves into species which grew attached to other bodies and those which may have rested on other surfaces and so have taken a flattened form but were not permanently fixed. To the former, apparently, belong all or nearly all of the earlier species as well as the Devonic Agelacrinites hamiltonensis, the supradevonic A. buttsi and A. legrandensis. So far as the evidence goes, A. alleganius, A. kaskaskiensis (A. optatus), A. sampsoni, A. squamosus, A. beecheri, all late species, were not attached, even in pretty early growth stages. Thus, while fixation continued throughout the history of the group as a species character, freedom from fixation pertained almost wholly to the latest representatives, save in cases where notable degeneration had set in. Such permanently attached species as pass beyond Devonic time are also marked by the persistence of a primitive expression in other respects, in size, shortness and directness of arm, and breadth and composition of the marginal border.

Summary. It appears from the foregoing that we may leave out of consideration as a generic character of the agelacrinites the variation in the direction of the rays and may consider as structures of convenient generic value 1) the character of the thecal plates, whether *a*) squamous or *b*) mosaic, and if the latter, whether *1*) polygonal and smooth or, *2*) irregular and sculptured; 2) the character of the rays, whether *a*) long and whiplash

shaped, with narrow, arched cover plates or *b*) shorter and broader, with broad and long cover plates; 3) the presence and structure of a peripheral band either *a*) composed of few large plates with very fine ones on the outer edge or *b*) broad with a great number of small plates.

So far as the generic names actually proposed are concerned, they are found to embrace the before mentioned characters in the following manner.

Agelacrinites: *thecal plates* mosaic, irregular, sculptured
rays very long and narrow
peripheral band composed of large plates with very small ones at the margin
A. hamiltonensis Vanux.

Discocystis (=Echinodiscus=Ageladiscus): *thecal plates* mosaic, polygonal, smooth
rays very long and narrow
peripheral band composed of a few large plates with no fine ones outside of them
D. kaskaskiensis Hall
D. sampsoni Miller

Lepidodiscus: *thecal plates* squamous
rays very long and narrow
peripheral band very narrow or extinguished, composed of large and small plates; the latter few, the former projecting on the aboral surface
L. squamosus Meek
L. alleganius sp. nov.

These generic names strictly construed, as they must be to maintain a definite value, leave a commanding number of agelacrinites without farther appellation. We do not zealously contend for the value of such divisions among these later Agelacrinites. If any fact is made clear by the foregoing observations it is that passage conditions from one to another of the typical species of proposed genera of these bodies do exist in such measure as to obscure the validity of the divisions. Nevertheless such terms may be used helpfully till our knowledge

affords a better basis for interpreting the affinities of these organisms. Both convenience and necessity seem to require the continued employment for the present of the term Agelacrinites in a broad sense for such species as have not been or can not yet be subjected to close analysis, but in such a case the name should, I believe, be used with full admission of the fact that it is merely a term of convenience and not to be confounded with the strictly defined genus Agelacrinites.

Lepidodiscus alleganius *sp. nov.*

Pl. 10, fig. 1–5

Disks compressed, with gently convex upper, and somewhat concave lower surface; sessile but not firmly attached or cemented.

Oral surface. Rays five, all contrasolar; very narrow, direct or gently sinuous near their origin for about half their length; then bending more or less abruptly, the extremital part running close within or subparallel to the margin and varying in its curvature, assuming the aspect of a whiplash. Oral aperture elongate, and from each extremity arise two of the rays, the fifth departing from the middle of the upper edge and lying opposite the anal pyramid. In all observed specimens the ambulacral plates are concealed by the rows of cover plates with their convex interlocking edges represented by a fine, serrated median line on all rays; this line also extends over the oral area. Anal pyramid circular, composed of 10 triangular plates.

Thecal plates on interradii imbricating, with no difference apparent in the plating of the anal interradius. The imbrication is in all cases directed centripetally or toward the mouth. Marginal plates not noticeably larger or more prominent on this surface.

Aboral surface. Depressed, with projecting periphery composed of more prominent plates. General surface with imbricating plates clearly shown. Here, however, the direction of the imbrication is centrifugal or away from the center of the disk and is thus continuous in direction with the imbrication of the upper or oral surface.

Young stages. In the earliest growth observed the rays are direct and pass to the margins without curvature, ending there so abruptly as to convey the impression that they extend over the margin to the lower surface. In the young example figured the rays are still direct, but show a gently undulating course to the margin. The aboral surface of none of these young forms has been seen. Many examples of this species and all the young specimens are casts of the exterior. Some of the young examples present rays which are but very slightly elevated along the cover plates and have deeply impressed and broad marginal furrows.

Dimensions. Adult specimens have a diameter of from 35 to 50 mm, and the smallest observed is 13 mm in diameter.

Geologic horizon and localities. In the Chemung sandstones at and near Alfred, Belvidere and Wellsville N. Y., and 2 miles south of Sabinsville, Tioga co. Pa.

Agelacrinites beecheri *sp. nov.*

Fig. 4–6

Body of medium size, sessile, but not permanently attached; highly convex on the oral surface with steep marginal slopes. Aboral surface flat or concave.

Thecal plates squamous, imbricating and conspicuous over the interradii. Marginal plates just outside of the arms irregularly elongate but not much larger than those of the interradii. Outside of this is a wall of numerous small and acute peripheral plates.

Rays 5, departing from a deeply quinquepartite and hence small and narrow, oral depression; flagellate, 4 contrasolar, 1 solar, the latter adjacent to the anal pyramid with which it is approximate.

FIGS. 4–6 A. beecheri, natural size. FIG. 4 is from an internal cast of the oral surface, shows the direction of the rays but is defaced about the oral aperture. FIG. 5 is a fragment showing R 3, 4, 5 and the narrow oral aperture. FIG. 6 is an enlarged sketch of the subambulacral plates drawn from a squeeze of fig. 4.

Radial cover plates triangular and interlocking along the median line. At the base the ambulacra have a pavement con-

sisting of a single series of squamous plates overlapping distally along the length of the arm; each of these plates is sharply depressed at the side to form two deep pits corresponding to elevations on the marginal plates.

Horizon and locality. Lower Carbonic below the horizon of the Olean conglomerate at Warren Pa.

Observations. The specimens on which this description is based were collected by Prof. C. E. Beecher and are in the Yale museum. The best of the examples comprises internal and external casts of the body, the parts about the oral aperture being defaced. This specimen is specially interesting in affording evidence of the subambulacral plates. So far as known but two instances have passed on record of specimens in which the structure of these plates is shown, one a specimen of A. cincinnatiensis described by Meek, and the other the original specimen of Roemer's genus Haplocystites from the lower Devonic of the Rhine. Both of these instances are cited by Jaekel, who has given a new illustration of Haplocystites rhenana. It does not however appear from either of the instances cited that the pavement plates actually overlap each other as shown by this specimen of A. beecheri.

In size and many of its structural features A. beecheri is similar to A. lebouri Sladen from the lower Coal Measures of Waterhead, Cumberland (*see* for corrected figures Jaekel, *Stammesgeschichte der Pelmatozoen*, pl. 1, fig. 7).

Agelacrinites buttsi *sp. nov.*

Pl. 10, fig. 7–9

Disks small, cemented by the aboral surface. Oral surface convex medially, with very broad and flat marginal rim, sharply elevated on its inner edge and composed of minute imbricating plates. Rays five, four of which are solar, R 5 being contrasolar and facing R 1. These are narrow, extend to the edge of the border, their extremities curving close within this edge. Interradii composed of imbricating plates. Anal pyramid small and

well defined. In young stages the oral surface is much contracted, the marginal rim proportionally broader, and the rays are straight, passing directly to the elevated inner edge of the rim.

Nine of these individuals have been found attached to a fragment of a shell of Ptychopteria.

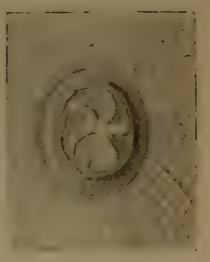


FIG. 7 A. buttsi, natural size. Lower Carbonic, Warren Pa.

Geologic horizon and localities. Specimens of various sizes have been found on the southwest slope of Mt Moriah about 1½ miles south of Russell station, Cattaraugus co. The horizon is regarded as above the range of the true Chemung fauna. It is about 100 to 150 feet above the Wolf creek conglomerate, lying between the latter and the Mt Hermon sandstone.

In the succession of faunas from below upward in this section, a marked change occurs at the Wolf creek conglomerate, notable both for the introduction of species having a postdevonic aspect and for the extinction of typical Chemung forms. Thus appears here a species of Oehlertella closely similar to O. pleurites, of the Ohio Waverly; all the Productellas have disappeared; Leptodesma potens, mortoni, sociale do not pass above this horizon; L. curvatum, maclurei, mytiliforme, orodes, etc. appear only above it. Likewise the Pararcas (3 species), the Ptychopterias for the most part (8 species), the Palanatinas (2 species) lie above it; the dictyosponges all lie below it.

A close analysis of the new elements introduced here shows various early Carbonic affinities, and none perhaps more emphatically than this species itself, A. buttsi. The expression of this fossil is primitive throughout and indicates the senile manifestations of race exhaustion. The species has also been found by Prof. Beecher at about the same horizon in the section at Warren Pa. Of similar structure and diminutive form are certain other agelacrinites described from the lower Carbonic, A. legrandensis Miller & Gurley, Kinderhook, A. blairi Miller, etc.

It would appear that the final stages of the development of the agelacrinites had taken diverse courses, one through Agelacrinites into the Lepidodiscus-Discocystis line to extinction (L. alleganius, D. kaskaskiensis, L. squamosus), the other into the expression of Agelacrinus buttsi, blairi, etc. which bear the stamp of the initiatory phases of the race.

Various writers have been disposed to separate the agelacrinites from the Cystidea. Billings having first introduced a distinctive name for the entire group, Edrioasteroidea. Jaekel proposed (1895) to term essentially the same group, Thecoidea. Of the subdivisions of this class the family Agelacrinitidae is well defined, though its members and their genetic relations are still promising subjects for study.

VALUE OF AMNIGENIA AS AN INDICATOR OF FRESH-WATER DEPOSITS

DURING THE

DEVONIC OF NEW YORK, IRELAND AND THE RHINELAND

BY JOHN M. CLARKE

Pl. 11

In 1842 Vanuxem described, from Mount Upton N. Y., as Cypricardites catskillensis and C. angustata, certain fossil clams, for which Hall at a later date erected the generic term Amnigenia, including both forms under the single name A. catskillensis. Neither Vanuxem nor Hall ventured to suggest that this organism was closely related to the existing fresh-water clams Anodonta or Unio, but this proposition has at various times been made without close analysis of its probabilities; more recently, however, it has been carefully discussed by Beushausen.[1]

The exterior resemblance of this mollusk to Anodonta is certainly most striking, but this fact contributes less to the indication of its fresh-water habit than the conditions under which its involving sediments were laid down. This clam has been found not only at Mount Upton, the original locality, but also, according to Prof. Hall, at "Gilbertsville, Otsego co.; on the road from Jefferson to Gilboa, and at the base of the hills to the south of Jefferson, Schoharie co. N. Y. Prof. J. J. Stevenson has found a single valve of this fossil in the Catskill red sandstone on Wills creek, about 1 mile from Hyndman, and 1600 feet above the base of the formation, in Bedford co. Pa." More recently it has been found in quantity and well preserved at Oxford, Chenango co. in the quarries of the F. G. Clarke bluestone co. Its occurrence in New York is, so far as known, restricted to the Oneonta sandstone, the origin and stratigraphic

[1] Jahrb. d. königl. preuss. geol. Landesanstalt für 1890. separat p. 1–10, 1891.

relations of which have been a fruitful theme of discussion. The evidence now seems fully to justify the interpretation of this deposit as a sediment accumulated in nearly or quite impounded fresh water or of brackish water cut off from the open sea on the west by a low, shifting submarine bank, not well defined in the stratigraphy save that outside of it flourished a profuse marine fauna; and on the east continuous with and marking the inception of the Catskill sedimentation. During the period of the existence of these Oneonta beds but few instances appear of incursions from deeper waters. Yet such are not absent. The washing in from the deep water of flotillas of Orthoceras which were apparently killed by contact with the fresh water and are preserved in myriads erect in certain of the strata, has been recorded by the writer as evidence of the instability of the outward boundaries of the catchment basin. Other than this these sediments are not known to contain marine fossils. The fishes, Bothriolepis, Coccosteus, Holoptychius, etc. which appear with more or less frequency, have not been regarded as of true marine habit; on the contrary, their allies in the Old Red sandstone of Scotland and Russia are distinctive features of the lakes of that time. There are evidences of ostracodes and worm trails over the sandy bottoms, but most abundant of all forms of life are the accumulated fragments and trunks of Psaronius, Lepidodendron, Archaeopteris, and other plant remains.

There are other species of Amnigenia occurring in the Devonic, and these serve to strengthen very substantially the deductions made possible by the New York form.

Forbes long ago described[1] as Anodonta jukesi, a shell from Kiltorcan, Ireland. Beushausen, who has recently studied specimens of this fossil in the collections of the Landesanstalt at Berlin, ascribes it to Amnigenia, and notes its occurrence in sandstone beds associated with conglomerates and variegated shales underlying the Coal Measures. With regard to these Kiltorcan beds Sir A. Geikie has written as follows[2]:

[1] Geol. sur. Ireland. Mem. expl. sheets 147–57, p. 16, fig. 3a, b.

[2] Textbook of geology. 1893. p. 802.

The Old Red sandstone attains a great development in the south and southwest of Ireland. The thick "Dingle beds" and "Glengariff grits" pass down into Upper Silurian strata, and no doubt represent the Lower Old Red sandstones which cover them unconformably and resemble the ordinary Upper Old Red sandstone of Scotland. In Cork and the southeast of Ireland they are followed by the pale sandstones and shaly flagstones known as the "Kiltorcan beds", with apparently a perfect conformability. The Kiltorcan beds (which pass up conformably into the Carboniferous slate) have yielded a few fishes (Bothriolepsis, Coccosteus, Pterichthys, Glyptolepis), some crustaceans (Belinurus, Pterygotus), a fresh-water lamellibranch (Anodonta jukesi), and a number of ferns and other land plants (Palaeopteris, Sphenopteris, Sagenaria (Cyclostigma), Knorria).

The occurrence of A. jukesi is thus parallel in character and age to that of A. catskillensis.

Beushausen describes[1] as Amnigenia rhenana, a shell of about the size and proportions of A. catskillensis from various localities in the vicinity of Gräfrath in the Rhine province. The precise stratigraphic position of this species is not clearly established by the author cited, but from collateral evidence is regarded as probably of late middle Devonic age. The only fossils associated with it in the sandstone beds where it occurs are fragments of plants which are scarcely capable of identification. "This association with plant remains, as well as the character of the whole succession of sediments, doubtless indicates a near coast line, and one will not go far astray in concluding from the contemporaneous absence of all traces of a marine fauna, that these sediments are probably brackish water deposits".[2]

The Oneonta-Catskill sedimentation in its fullest development doubtless represents time from at least the close of the Hamilton stage. Prof. Hall was disposed in some of his writings[3] to regard the upper part of the Hamilton series of strata, as developed in central New York, as replaced eastward by the Oneonta beds. Present evidence may not fully corroborate this interpretation,

[1] Jahrb. d. königl. preuss. geol. Landesanstalt für 1890. separat p. 1–10, 1891.

[2] *Idem.* p. 2.

[3] *See specially* Pal. N. Y. v. 5, pt 1, 2, p. 517.

but it is however quite clear that the change in local conditions initiating this deposit of estuarine or fresh-water sediments manifested itself at a continually earlier period of the Devonic, as one proceeds eastward from central New York toward the Hudson river.

The three known occurrences of Amnigenia; A. catskillensis in New York and Pennsylvania, A. jukesi in Ireland and (according to Frech) in Devonshire, and A. rhenana in the Rhineland, are thus alike in the nature of the involving sediment, viz sandstones and sandy shales bearing terrestrial plant remains, but with a total absence of marine organisms; and are essentially equivalent in age, marking only different stages or levels during the continuance of Old Red sedimentation.

We have observed that data of this kind are stronger evidence of the fresh-water habit of this clam than any that can be derived from the structural characters of the fossils themselves in their present preservation. There is however in all a strong Anodonta or Unio aspect. As the hinge in these genera is normally but slightly diversified, little but negative evidence is to be expected from the fossils. The absence of hinge structures in all these cases is such evidence of much weight wherein we may find indication of close conformity in structure. Beushausen is disposed to caution in inferring, in the absence of more positive indications, immediate relationship to Unio or Anodonta, and concludes that, "though Amnigenia may be regarded as the forerunner of the recent Unios, one will do well not to infer a direct phylogenetic connection by the employment of the term Anodonta, for which all proof fails" (p. 8). We figure here a slab of Oneonta sandstone from the Clarke quarry at Oxford, which bears 30 shells of A. catskillensis on a surface 14 by 10 inches. Some of these shells have apparently been drifted into their places, but several present the appearance and attitude of shells which had been boring in the mud. The valves are all double and closed, so that they must have been buried fast in the sediment while alive or before

decomposition relaxed the adductor muscles sufficiently to permit the valves to gape. All lie at an oblique angle across the lines of sedimentation and seem to have been exposed just as they died and were buried in their holes or washed into the mud at the bottom of the coastal lake. This specimen has been presented to the museum by E. E. Davis esq. of Norwich N. Y.

EXPLANATION OF PLATES

All specimens figured on plates 1–7 are from the lower Trenton conglomerate of Rysedorph hill, Rensselaer co. N. Y., if not otherwise stated.

PLATE 1

(All originals in state museum)

Bolboporites americanus Billings

p. 11

Fig.

1 A somewhat weathered specimen. x 3
Pebble of group 3

Stomatopora inflata Hall *sp.*

p. 12

2 A somewhat turgid variety. x 10
3 A normal form. x 10
Pebbles of group 5

Siphonotreta minnesotensis Hall & Clarke

p. 14

4 A pedicle valve. x 4
5 Lateral view of same. x 4
Pebble of group 5

Plectambonites sericeus Sowerby *var.* **asper** James

p. 18

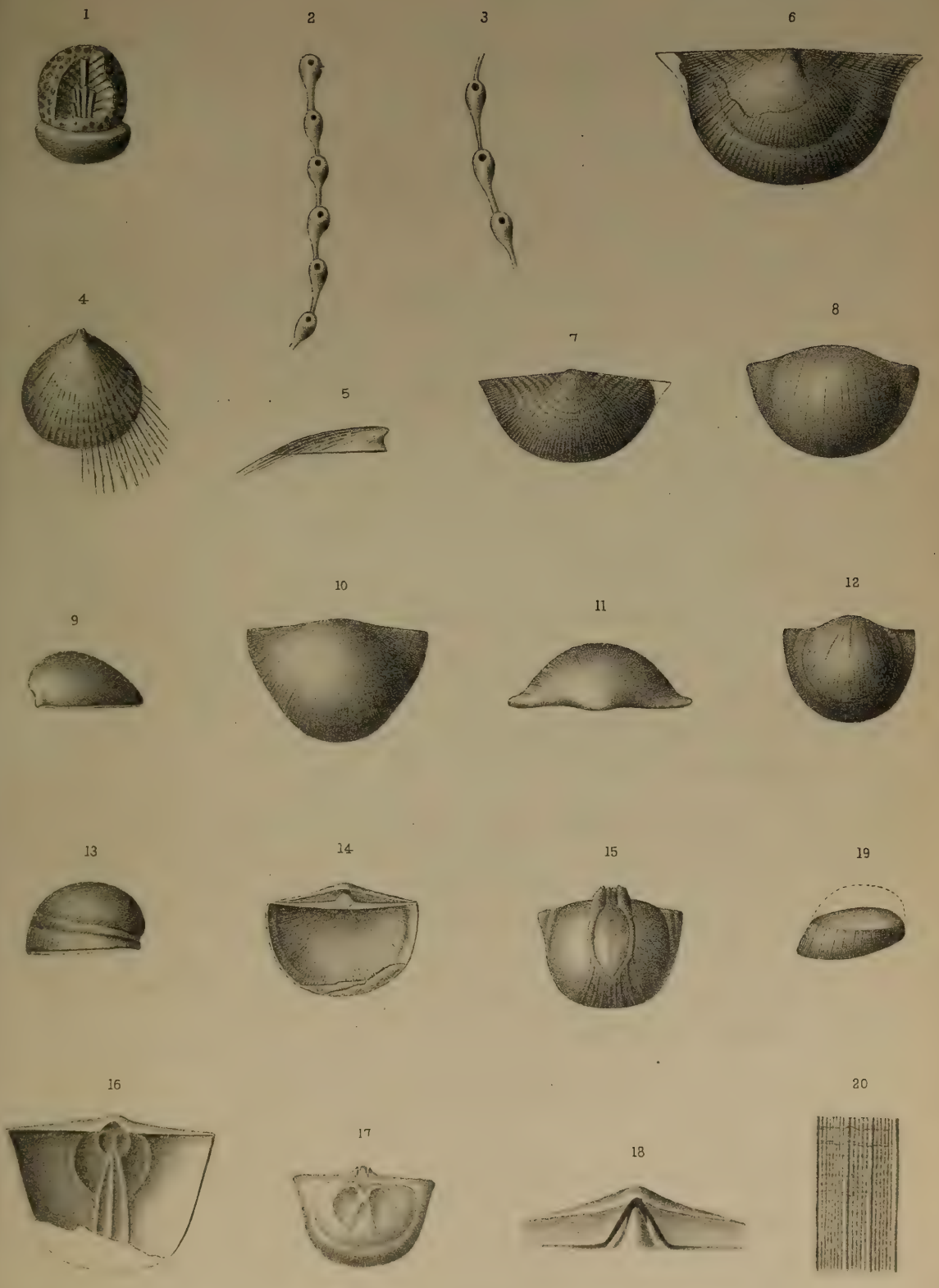
6 An adult specimen, showing well developed cardinal corrugations. x 2
7 A younger specimen with still stronger corrugations. x 2
Pebbles of groups 6 and 7

Plectambonites pisum *sp. nov.*

p. 19

8 A pedicle valve with relatively long cardinal line. x 2
9 Lateral view of same. x 2
10 A less tumid pedicle valve. x 2
11 Posterior view of same. x 2
12 Pedicle valve of normal dimensions. x 2

RYSEDORPH HILL FOSSILS



G.B. Simpson del. James B. Lyon. State Printer. Phil. Ast, lith.

Fig.

13 Lateral view of same. x 2

14 Brachial valve. x 2

15 Internal cast of pedicle valve showing casts of muscular and vascular impressions. x 2

16 Interior view of pedicle valve showing muscle impressions and vascular trunks. x 2

17 Interior view of brachial valve. x 2

18 Cardinal process and crural plates. x 2

19 Broken shell showing the geniculate character of the posterior and lateral margins. x 2

20 Enlargement of surface. x 5

Pebbles of group 5

PLATE 2

(All originals in state museum)

Rafinesquina alternata Emmons *sp.*

p. 16

Fig.

1 One of the specimens of large size and strong cardinal extensions occurring in pebbles of group 7. Natural size

Christiania trentonensis *sp. nov.*

p. 21

2 Pedicle valve, somewhat exfoliated. x 2

3 Lateral view of same. x 2

4 Brachial valve. x 2

5 The interior of a brachial valve showing the quadruple adductor scar divided by high, vertical, muscular walls. x 2

6 Further enlargement of the cardinal region of the same showing the bilobed cardinal process and the denticulations on either side of the latter

Pebbles of group 5

Liospira americana Billings *sp.*

p. 31

7 Section natural size

Pebble of group 5

Cyrtospira attenuata *sp. nov.*

p. 35

8 Dorsal view. x 2

Pebble of group 7

Eccyliopterus spiralis *sp. nov.*

p. 34

9 Upper side of specimen. Natural size

10 Lateral view of same showing a portion of the collarlike upper carina. Natural size

Pebbles of group 5

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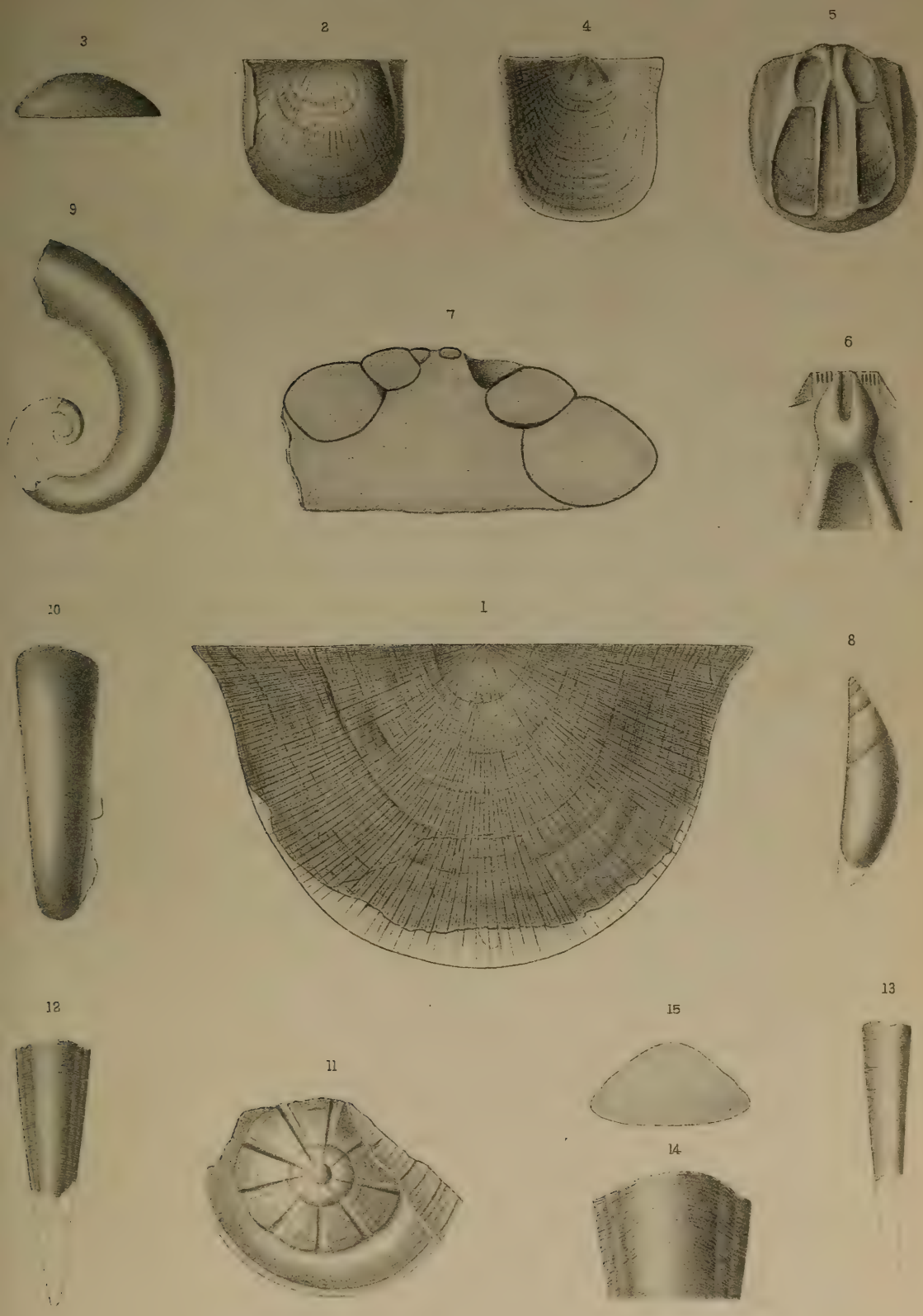

Hyolithellus micans Billings

p. 38

Fig.

11 Internal cast of operculum. x 20
Pebble of group 1

Hyolithus rhine *sp. nov.*

p. 36

12 Dorsal view of specimen. Natural size
13 Lateral view of same. Natural size
14 Enlargement of distal part of upper side. x 2
15 Section of shell. x 2
Pebble of group 6

PLATE 3

(All originals in state museum)

Ampyx (Lonchodomas) hastatus *sp. nov.*

p. 48

Fig.

1 Pebble with cranidium of this species and stipe of Climacograptus scharenbergi. x 2

2 Cranidium of mature specimen viewed obliquely to show the glabella. x 2

3 Dorsal view of same. x 2

4 Lateral view of same. x 2

5 Cranidium of a younger specimen. x 3

6 Cranidium of the youngest specimen observed. x 2

7 Cast of the posterior part of the glabella showing two transverse, elliptic projections

8, 9 Two specimens retaining part of the rostrum, which in both is bent upward and in the latter also backward. x 2

10 Pygidium of a small specimen showing a pronounced median protuberance of the axis. x 5

30 Fragments of a partly decorticated pygidium showing the muscular impressions. x 5

Pebbles of groups 5 and 6

Tretaspis diademata *sp. nov.*

p. 46

12 Frontal view of cranidium. x 2

13 Dorsal view of same; posterior parts of glabella and cheeks not as well preserved as indicated by the drawing. x 2

14 Lateral view of same. x 2

Pebble of group 5

Tretaspis reticulata *sp. nov.*

p. 41

11 Pygidum. x 3

15 Cranidium of an adolescent specimen, showing the eye-lines, eye-tubercle and tubercle and crest on glabella. x 3

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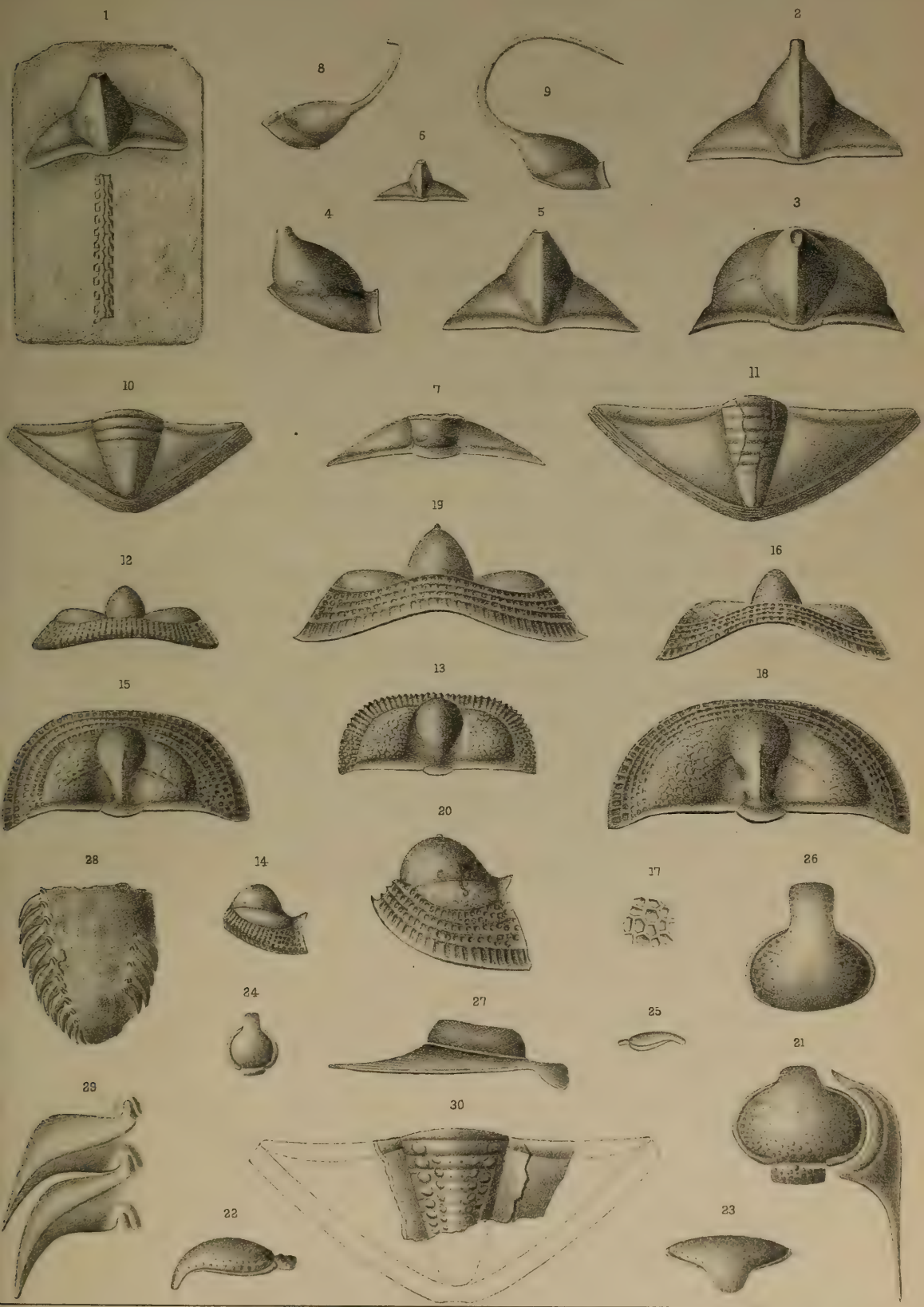

Fig.

16 Frontal view of same. x 3

17 Enlargement of reticulate surface. x 6

18 Cranidium of a supposedly mature specimen, showing similar features. x 3

19 Frontal view of same. x 3

20 Lateral view of same. x 3

Pebbles of group 5

Remopleurides (Caphyra) linguatus *sp. nov.*

p. 56

21 Dorsal view of cranidium and right free cheek. The shading represents the glabella as too convex. (Compare fig. 23) The free cheek was not found in the position figured. x 3

22 Lateral view of same. x 3

23 Frontal view of same. x 3

24 Cranidium of the smallest specimen observed. x 4

25 Lateral view of same. x 4

26 Cranidium figured in a position to show the length and form of the tonguelike process of the frontal lobe. x 4

27 Lateral view of free cheek, showing the delicate faceting of the eyes, and the rudderlike frontal doublure. x 5

28 Thorax, the central part destroyed by weathering. x 2

29 Enlargement of the pleurae, to show the fulcral tubercles. x 5

Pebbles of groups 5–7

PLATE 4

(All originals in state museum unless otherwise stated)

Isotelus *cf.* maximus Locke

p. 59

Fig.

1 Pygidium of a very young example partly decorticated and showing muscular impressions. x 5
Pebble of group 7

Remopleurides tumidus *sp. nov.*

p. 54

2 Dorsal view of cranidium. x 2

3 Frontal view of same. x 2

4 Lateral view of same. x 2
Pebble of group 6

Cyphaspis matutina *sp. nov.*

p. 62

5 Dorsal view of the cranidium of a very young specimen. x 10

6 Lateral view of same. x 10

7 Cranidium of an older (mature?) specimen. x 5
Pebbles of group 5

Cyphaspis hudsonica *sp. nov.*

p. 64

8 The only cranidium found, which is slightly flattened or crushed, and the occipital ring missing. x 4

9 Lateral view of same. x 4
From the upper Utica shale of Green Island

Bronteus lunatus Billings

p. 65

10 Small cephalon. x 3
From pebble of group 5

11 Copy of Billings's original drawing of this form
Trenton limestone, Ottawa, Canada.

Cybele *sp.*

p. 66

12 Anterior part of a pygidium from a gutta-percha impression. x 5
Pebble of group 7

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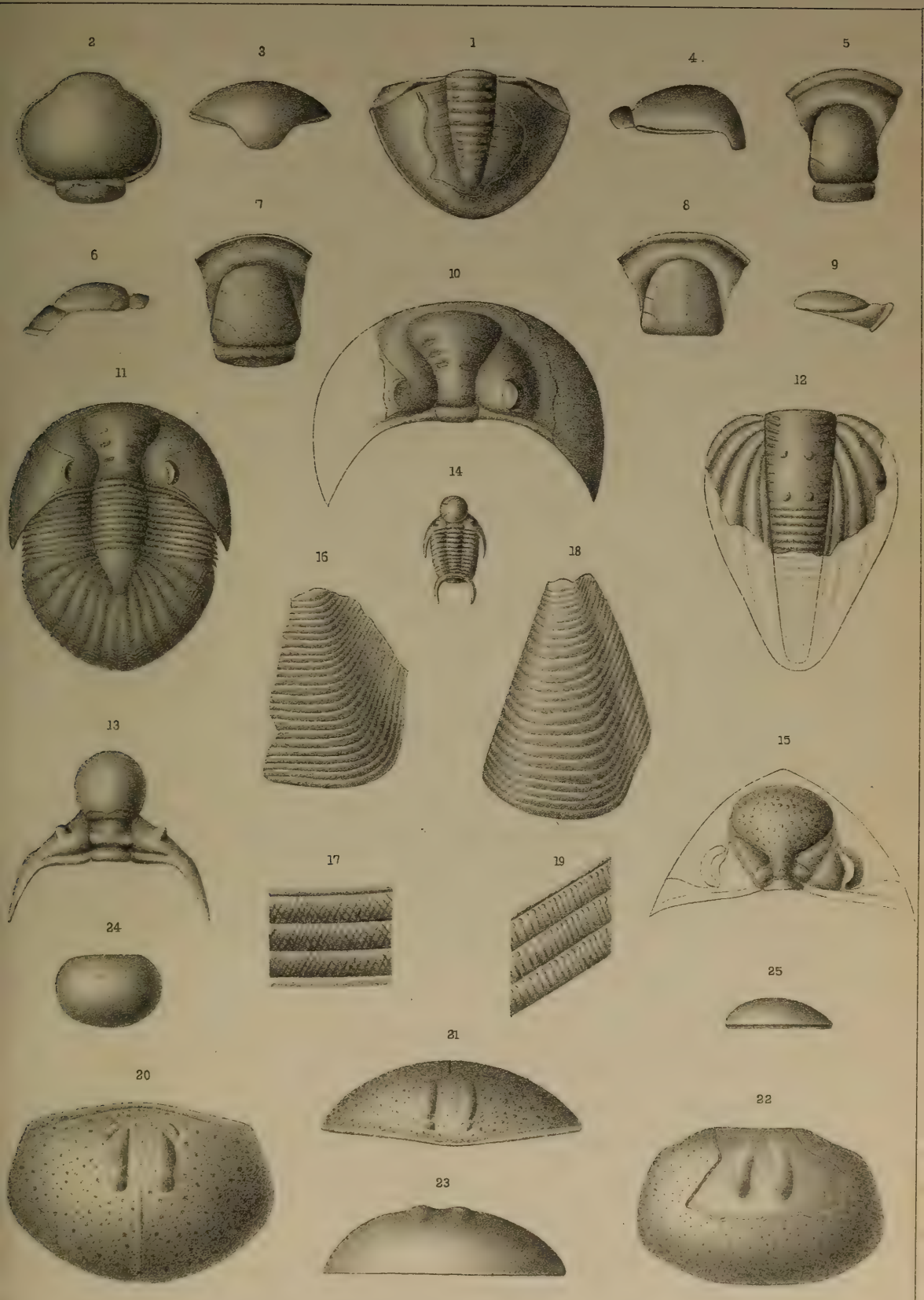
Bull. 49 N.Y. State Museum — Plate 4



G.B. Simpson del. — James B. Lyon, State Printer — Phil. Ast, lith.

Sphaerocoryphe major *sp. nov.*
p. 67

Fig.

13 Dorsal view of cranidium partly restored at the genal angles. Natural size

From a pebble of group 5

14 Copy of a mature specimen of Sphaerocoryphe robustus Walcott, in the state collection. Natural size

Pterygometopus eboraceus Clarke
p. 69

15 A cranidium. x 2

Pebble of group 7

Lepidocoleus jamesi Hall & Whitfield *sp.*
p. 87

16 A plate retaining the surface sculpture. x 10

17 The latter enlarged. x 25

18 Another plate where one of the two systems of striations is more strongly developed. x 10

19 Surface sculpture. x 25, showing the minute nodes appearing where the cross-striations intersect the transverse striae. The nodes are drawn a little too prominent.

Pebbles of group 5

Problematic crustacean

20, 21 Two views of the periderm of an organism which on account of the substance, general form and porosity of the shell probably belonged to the crustaceans. The symmetry of form shown in the outline of the shell and the position of the nodes would combat a reference of the form to the Ostracoda, which, at first glance, are suggested by the general form. It is possible that the specimens may be the head shields of a species belonging to the Merostomata. The description of the form is deferred till a fuller series of specimens has been obtained. x 10

22, 23 Two views of another, partly decorticated specimen, which show that the underside of the shell possesses depressions corresponding to the nodes. x 10

24, 25 Two views of a very small shell probably belonging to this organism, showing two faint symmetrically arranged nodes. x 10

Pebbles of group 7

PLATE 5

(All originals in state museum)

Eurychilina dianthus *sp. nov.*

p. 78

Fig.

1 A partly exfoliated right valve showing an elongate prominence on the internal cast. x 22

2 Another right valve retaining the granulose surface. x 22

8 The largest value observed; exhibits a faint, subcentral muscle impression. x 17

9 Frontal view of same. x 17

Pebbles of group 7

Eurychilina reticulata Ulrich

p. 76

3 A right valve, x 22, from a pebble of group 6

Eurychilina subradiata Ulrich *var.* **rensselaerica *var. nov.***

p. 77

4 Left valve. x 22

5 Section of same across central portion of valve. x 22

6 Right valve. x 17

7 Right valve; frill partly broken away and showing the internal cast. x 17

13 Entire right valve showing pits on surface and radially striated border. x 22

Pebbles of groups 6 and 7

Eurychilina obliqua *sp. nov.*

p. 79

10 An entire right valve showing the broad, finely striated frill. x 14

11 Posterior view of same. x 14

12 Ventral view of same. x 14

Pebble of group 7

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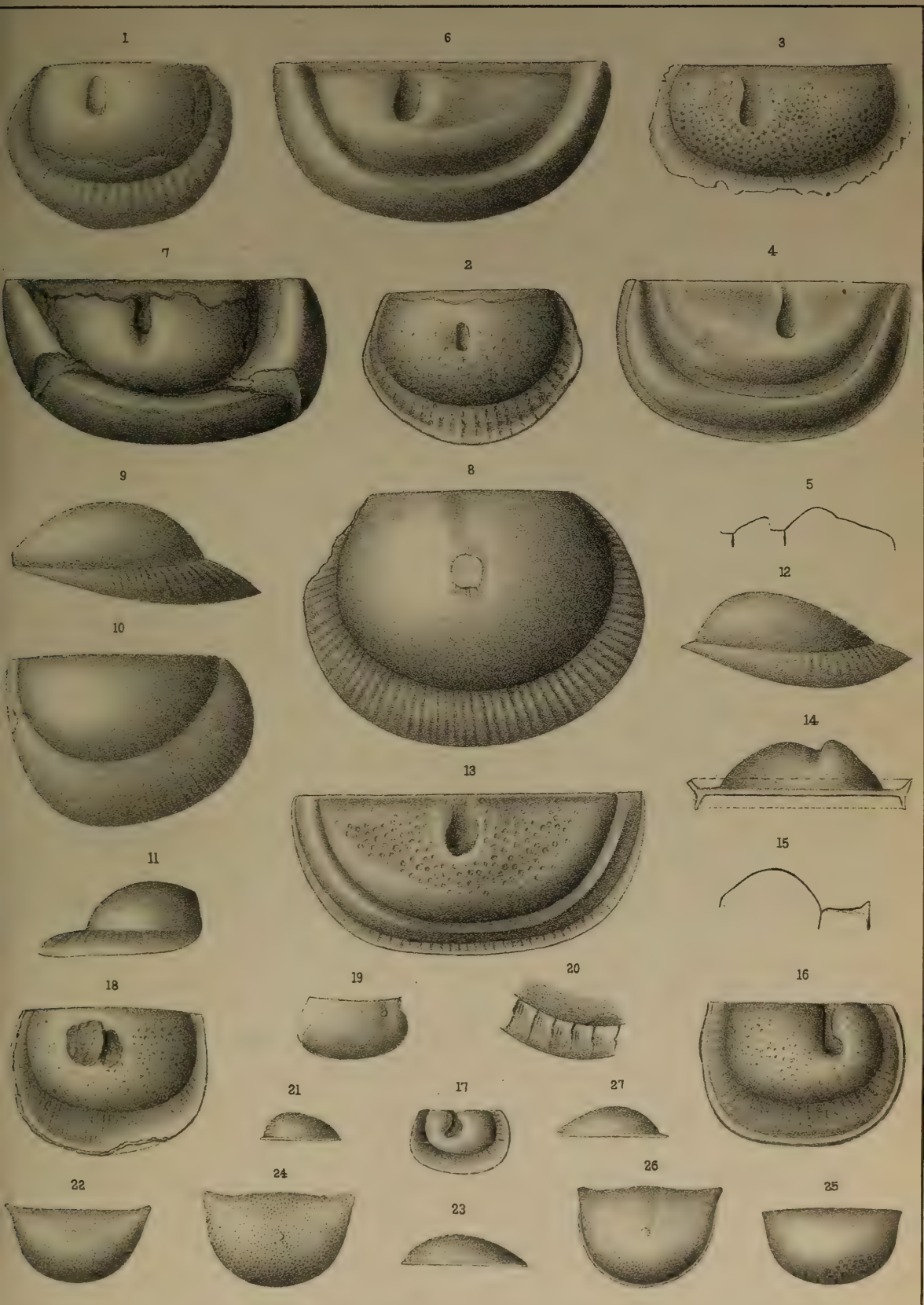

G.B. Simpson del. James B. Lyon. State Printer. Phil. Ast. lith.

Eurychilina bulbifera *sp. nov.*

p. 76

Fig.

14–16 Ventral view, cross-section and lateral view of an entire left valve. x 22

17 A small right valve. x 22

Pebbles of groups 6 and 7

Eurychilina (?) solida *sp. nov.*

p. 77

18 Only valve found. x 22

Pebble of group 7

Leperditia fabulites Conrad *sp.*

p. 70

19 A right valve. Natural size

20 Enlargement of ventral border of same. x 10

Pebble of group 7

Leperditia resplendens *sp. nov.*

p. 71

21-23 Anterior, lateral and ventral views of a perfect right valve. x 17

24 Another right valve having the entire surface pitted. x 17

25 A valve in which only the ventral part shows a somewhat coarse pitting. x 17

26, 27 Lateral and posterior views of a valve which has the ventral region pitted. x 17

Pebbles of groups 6 and 7

PLATE 6

(All originals in state museum)

Bollia cornucopiae ***sp. nov.***

p. 82

Fig.

1 Only valve found. x 22

2 Posterior view of same. x 22

Pebble of group 7

Macronotella fragaria ***sp. nov.***

p. 85

3-5 Lateral, ventral and posterior views of a right valve. x 18

Pebble of group 7

Macronotella ulrichi ***sp. nov.***

(*See* pl. 7, fig. 1)

p. 83

6-8 Three views of a coarsely pitted right valve with faintly indicated border. x 22

9 Lateral view of a right valve with distinct border and subcentral muscle impression. x 22

10-12 Lateral, ventral and anterior views of the largest valve observed. x 22

13-15 Lateral, ventral and anterior views of a right valve which shows all the characters of the species well developed. x 22

16 A more convex valve with less distinct pitting. x 22

Pebbles of group 7

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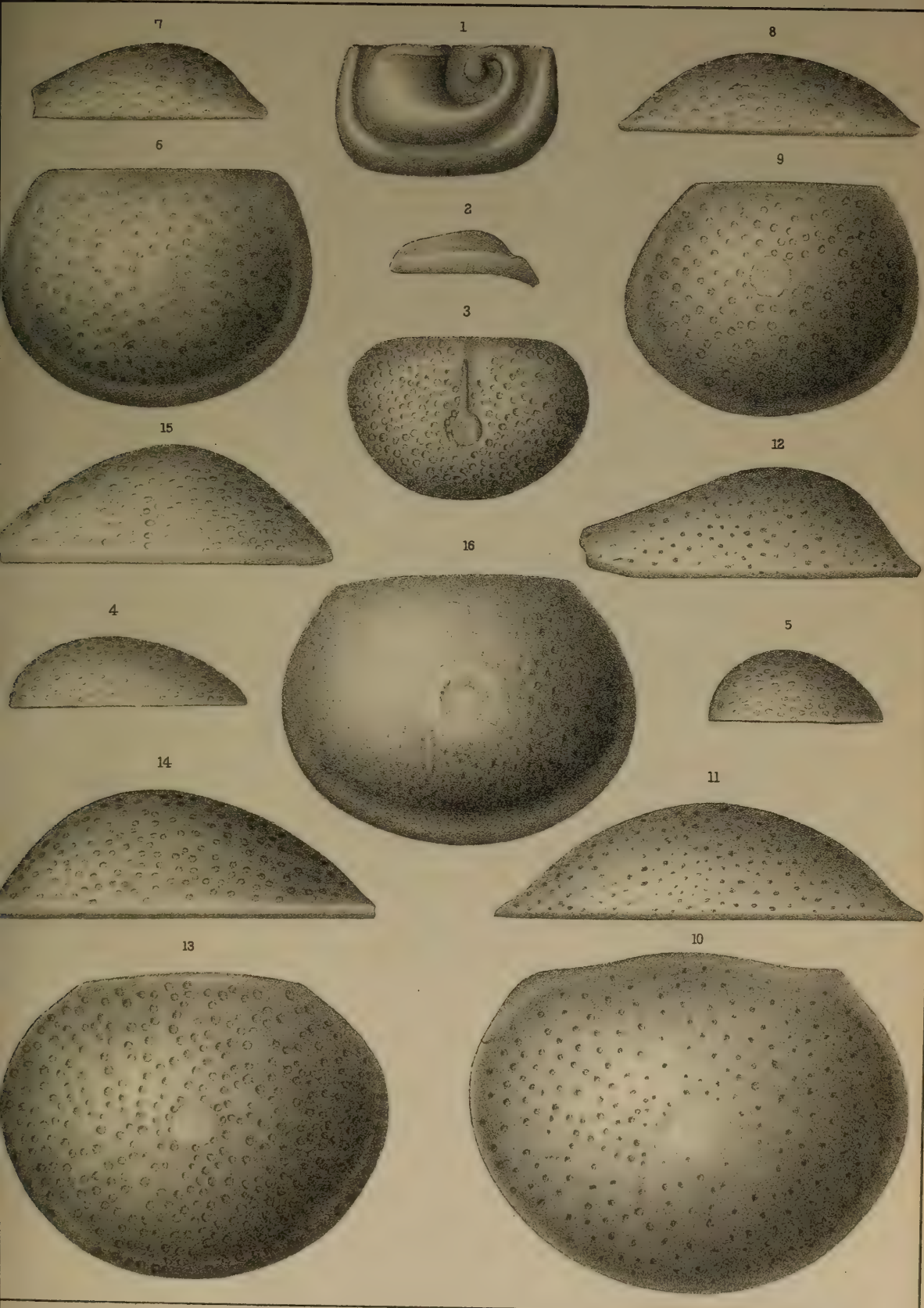

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PLATE 7

(All originals in the state museum)

Macronotella ulrichi *sp. nov.*

(*See* pl. 6, fig. 6-16)

p. 83

Fig.

1 Dorsal view of the valve represented in fig. 10-12 of pl. 6. The figure shows the reentrant cardinal area. x 22

Primitia mundula Miller *var.* **jonesi** *var. nov.*

p. 80

2 Internal cast of a small valve showing a tubercle at the end of the sulcus. x 22

3 Right valve. x 22

4 Vertical view of same, showing the border. x 22

5 Another right valve in which the longitudinally arranged granules give the surface a striated appearance. x 22

Pebbles of groups 5 and 7

Aparchites minutissimus Hall *var.* **robustus** *var. nov.*

p. 74

6-8 Lateral, anterior and ventral views of a right valve. x 17

9-11 Lateral, ventral and anterior views of the largest specimen observed. x 20

Pebbles of group 5

Schmidtella crassimarginata Ulrich, *var.* **ventrilabiata** *var. nov.*

p. 75

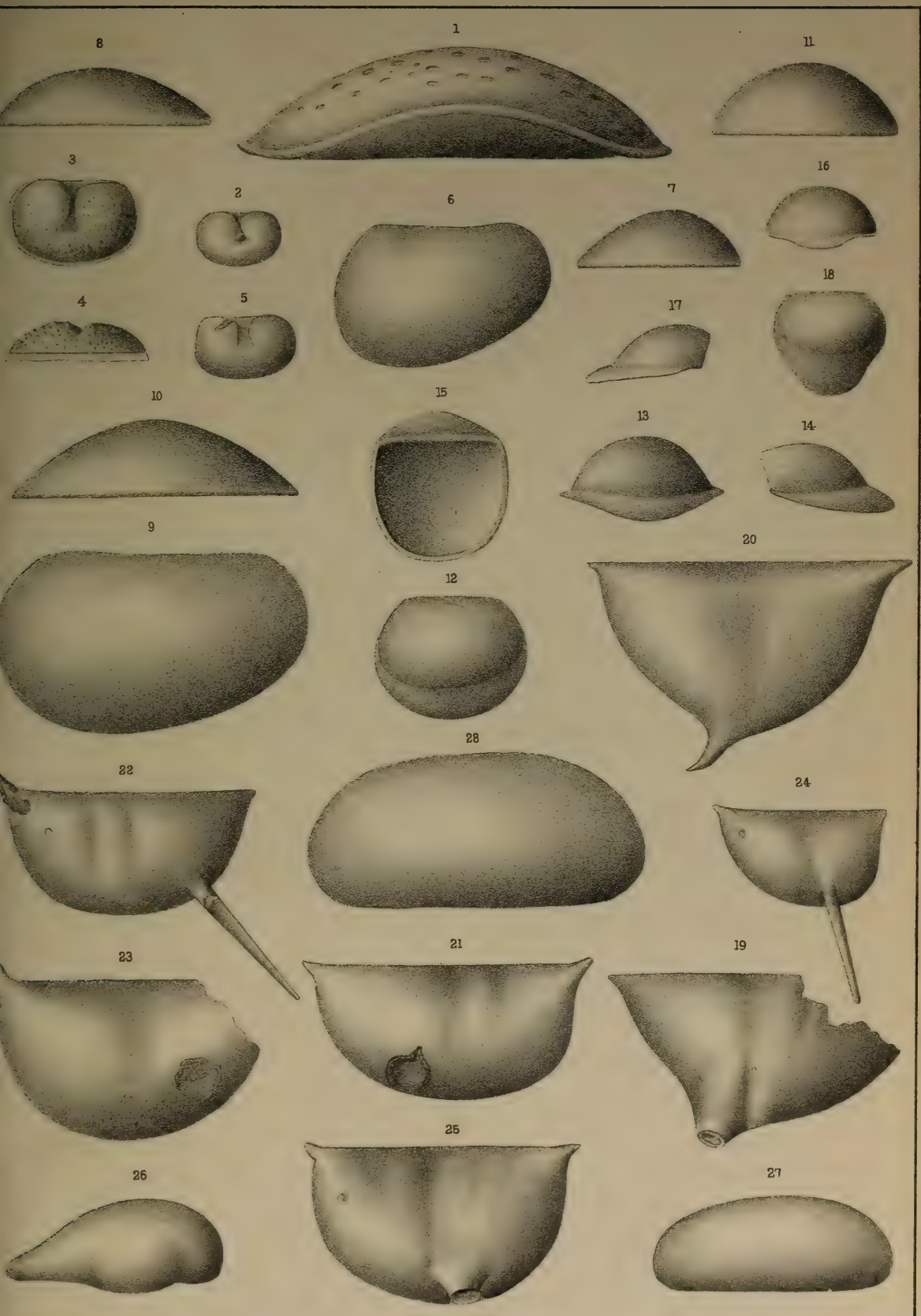
12-14 Lateral, ventral and posterior views of a left valve. x 22

15 Interior view of a valve showing the cardinal area. x 22

16-18 Ventral, terminal and lateral views of another left valve showing the ventral extension of the border. x 22

Pebbles of group 6

RYSEDORPH HILL FOSSILS



Isochilina armata Walcott *var.* **pygmaea** *var. nov.*

p. 72

Fig.

19 A somewhat fragmentary right valve showing a deep depression in front of the spine. x 22

20 A perfect right valve possessing a short unciform spine. x 22

21 A somewhat elongate right valve with distinct cardinal mucros. x 22

22 A small left valve possessing a long, straight spine and two faint depressions. x 22

23 A very obese left valve with very strong anterior mucro. x 22

24 The smallest valve observed; possesses long straight spine and distinct eye tubercle. x 22

25 A left valve with broad depression and eye tubercle. x 22

Pebbles of groups 5 and 6

Bythocypris cylindrica Hall *sp.*

p. 87

26 A left valve with a remarkable tumidity of the ventral region. x 22

27, 28 Two other specimens showing slight variations in outline from the average examples. x 22

Pebbles of groups 5-7

PLATE 8

(All originals in the state museum)

Thoracoceras wilsoni *sp. nov.*

p. 126

Fig.

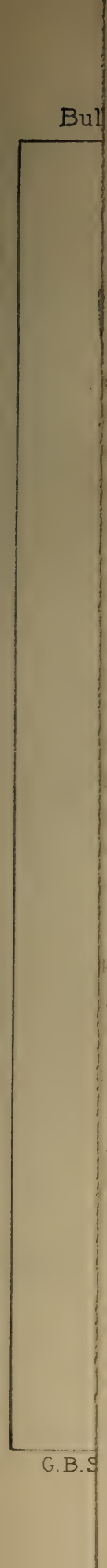
1-3 Three views of an internal cast; ventral, lateral and dorsal. This specimen retains the entire body chamber with aperture and 17 septa; shows the strongly prismatic sides which gradually become obscured over the body chamber, the broad inner flattening or impressed zone which is continued to the aperture, the gentle constriction of the body whorl and the lateral sinuosity of the aperture.

4 A cross-section of the same specimen showing the angularity of the septate portion, the relatively great breadth of the impressed zone and the gentle concavity of all the sides.

5 The exterior of a part of the body whorl of the same specimen from a gutta-percha squeeze, showing the sinuosity of the aperture, the continuation of both vertical and transverse ridges in an obscured condition with low nodes at their intersection over this surface, and in addition thereto the very fine concentric lineation of the shell.

6 The exterior of another specimen obtained by the removal of the shell from the matrix by calcination, the drawing being made from a gutta-percha squeeze. This covers mainly the septate part of the shell, shows the annuli and vertical ridges with their strongly nodose intersections. In other specimens these nodes are seen to be at times acute and spiniform. The specimen also shows the finer concentric lineation of the surface.

Agoniatites limestone. Manlius N. Y.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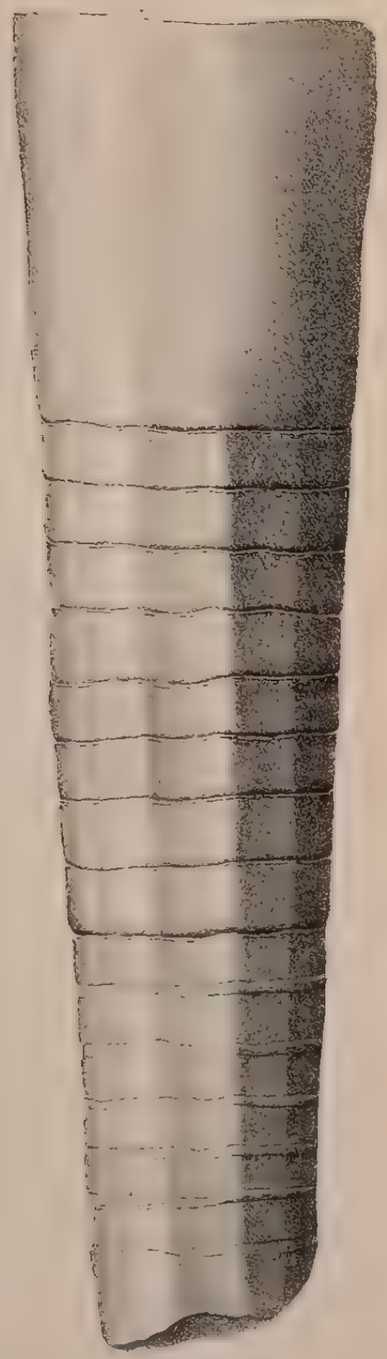

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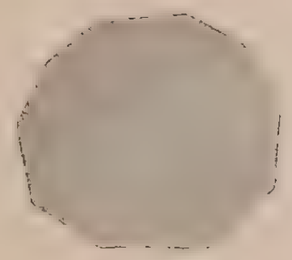

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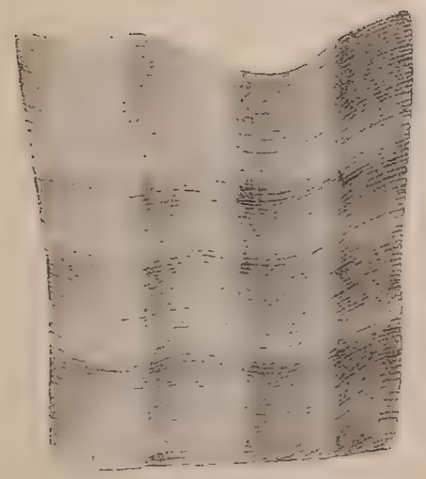

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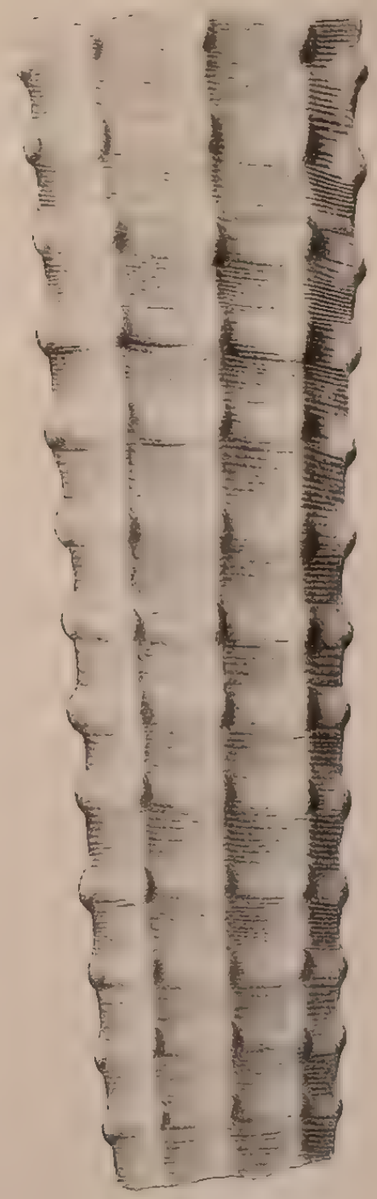

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PLATE 9

(All originals in the state museum)

Crania recta *sp. nov.*

p. 157

Fig.

1 The upper valve with outlines of dorsoventral and lateral sections. x 3

2 Mold of upper valve, with portion of shell attached, showing muscular scars. x 3

3 View of another specimen similarly preserved

Chonetes scitulus Hall

p. 159

4 Pedicle valve of small specimen showing a faint sinus. x 2

5 A large pedicle valve. x 1

6 Section of above. x 1

Camarotoechia pauciplicata *sp. nov.*

p. 162

7–9 Dorsal, anterior and ventral views of a specimen from the Stafford limestone of Genesee county. All x 2

10 Pedicle valve of a specimen from which the beak has been broken. x 2

11 Lateral view of the same. x 2

12 Dorsal valve. x 2

Camarotoechia prolifica Hall (?)

p. 162

13 Dorsal view of a specimen with beak restored. x 2

14 Lateral view of the same. x 2

15 Ventral valve. x 2. The beak is restored from another specimen.

Leptodesma marcellense Hall

p. 167

16 Left valve of a small specimen which is somewhat less oblique than the typical form. x 3

17 Left valve of the normal form. x 3


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Lunulicardium fragile Hall

p. 168

Fig.

18 A large left valve with an unusually broad anterior expansion. x 3

19 A similar specimen from the lower shale beds. x 3

Onychochilus (?) nitidulus Clarke ?

p. 170

20 A small exfoliated specimen. x 10

Ambocoelia nana Grabau

p. 165

21–23 Ventral, lateral and dorsal views showing the spinous surface, transverse form and small size compared with A. spinosa Clarke. x 3

All specimens are from the Stafford limestone of Lancaster N. Y. unless otherwise indicated.

PLATE 10

(All originals in state museum unless otherwise stated)

Lepidodiscus alleganius *sp. nov.*

p. 194

Fig.

1 A young individual, oral aspect. The rays are direct or but slightly undulating, reach the margin and terminate there if not extending somewhat on to the lower surface of the test. The structure of the rays and mouth is lost, but the former are seen to lie in well defined grooves. x 1½

Chemung sandstones. Loose at Alfred N. Y.

2 The aboral aspect of a large individual, showing the depressed surface of imbricating plates directed centrifugally and the projecting margin of coarser plates. Normal size

Chemung sandstones. Loose at Belvidere N. Y.

3 Oral aspect of a mature individual, showing the extremely narrow undulating whiplash rays, all solar; the elongate oral aperture and mode of divergence of the rays therefrom; the fine interlocking line of the cover plates. Also the position of the anal pyramid and the absence of specially differentiated marginal plates. x 1½

Chemung sandstone. 2 miles north of Sabinsville, Tioga co. Pa.

4 Oral aspect of another adult, showing similar characters, some of them more pronounced. Here the anal pyramid shows its composition of 10 triangular plates. x 1½

Chemung sandstones. Loose at Alfred N. Y.

5 Aboral aspect of a large individual

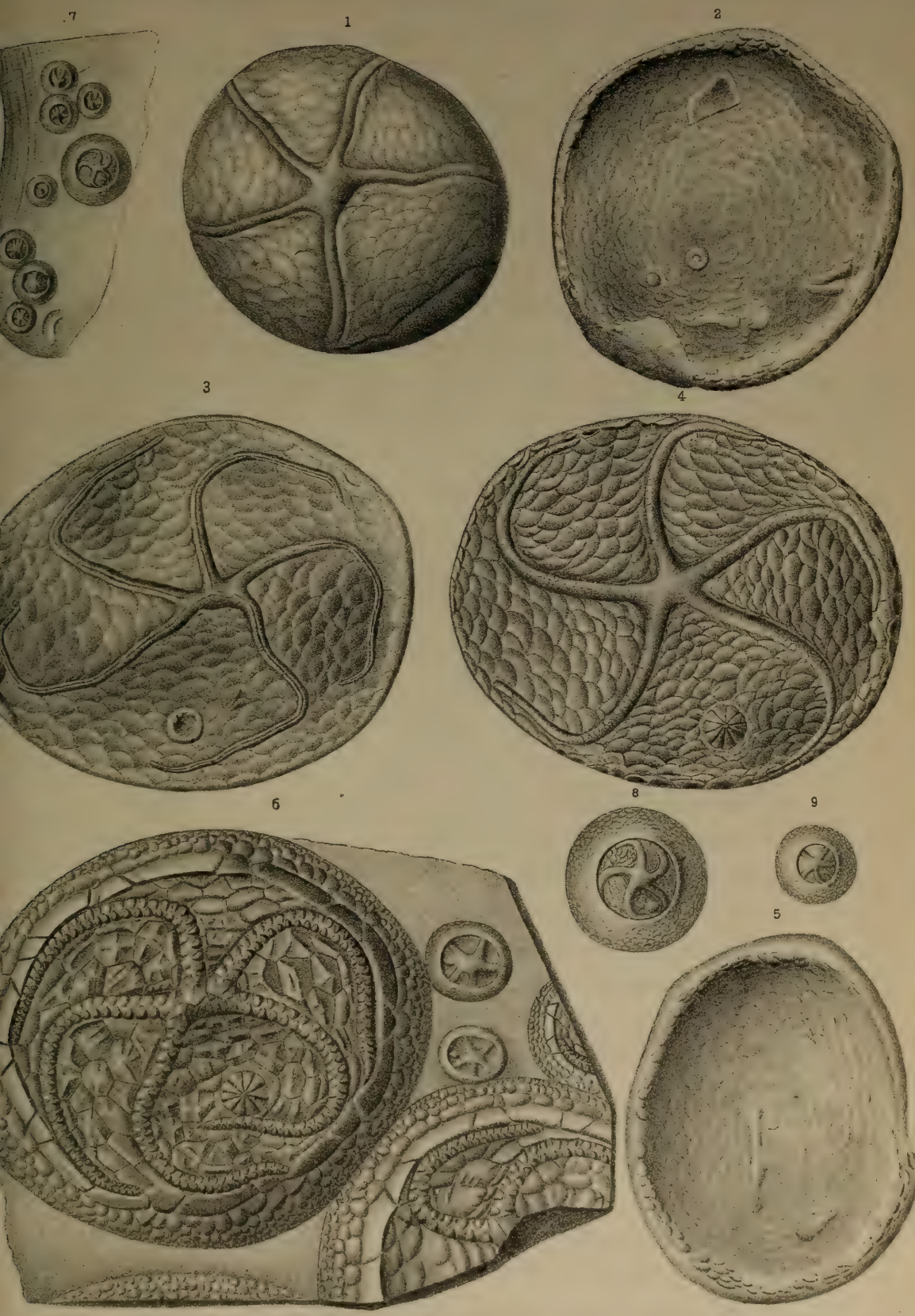
Chemung sandstones. Loose at Belvidere N. Y.

Agelacrinites hamiltonensis Vanuxem

p. 184

6 A drawing made from a gutta-percha replica of the original. This replica, on comparison with Vanuxem's figure in the report on the geology of the third district, is seen to lack parts of two individuals, but it shows the detailed structure

AGELACRINITES



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of one adult with portions of five other individuals in various stages of growth. Noteworthy features of the adult are the form and direction of the rays, the large submarginal and small marginal plates and the sculptured surface of the interradial plates. The two very young individuals are specially interesting, as showing the relative width of the marginal area and the straight rays abutting against the broad border. x 2

This is not a reproduction of the figure given by Hall, in the 24th report of the New York state museum, but is a new drawing.

Hamilton beds. West Hamilton, Madison co. N. Y.

Agelacrinites buttsi *sp. nov.*

p. 196

Fig.

7 A cluster of individuals attached to a shell of Ptychopteria. Natural size

8 The largest of the individuals x 2. Showing the very broad border composed of small imbricating plates, R 1–4 contrasolar, R 5 solar and the imbricating interradial plates

9 A younger individual, in which the border is relatively much broader and the rays direct. x 2

Supradevonic sandstone (Cattaraugus beds) Mt Moriah, Cattaraugus co. N. Y.

PLATE II

(Original in the state museum)

Amnigenia catskillensis Vanuxem *sp.*

A slab of sandstone bearing 33 individuals of this species all with closed valves and buried in the mud at various angles across the lines of sedimentation. Reduced $\frac{1}{3}$

Oneonta sandstone. Oxford N. Y.

Plate 11

Amnigenia catskillensis

INDEX

Page numbers referring to descriptions of fossils are printed in black face type. The superior figures tell the exact place on the page in ninths; e. g. 168³ means page 168, beginning in the third ninth of the page, i. e. about one third of the way down.

University of the State of New York

State Museum

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Reports 1-4, 1881-84 were published only in separate form. Of the 5th report 4 pages were reprinted in the 39th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (for 1891), and 13th (for 1893) are omitted from the 45th and 47th museum reports.

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Paleontologist's reports. New York state museum. State paleontologist's annual report 1899–date. Albany 1900–date.

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Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have been published in volumes 1 and 3 of the 48th museum report and in volume 1 of the 49th, 51st and 52d reports. The botanical part of the 51st is available also in separate form. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and combined with others more recently prepared and constitute *Museum memoir* 4.

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